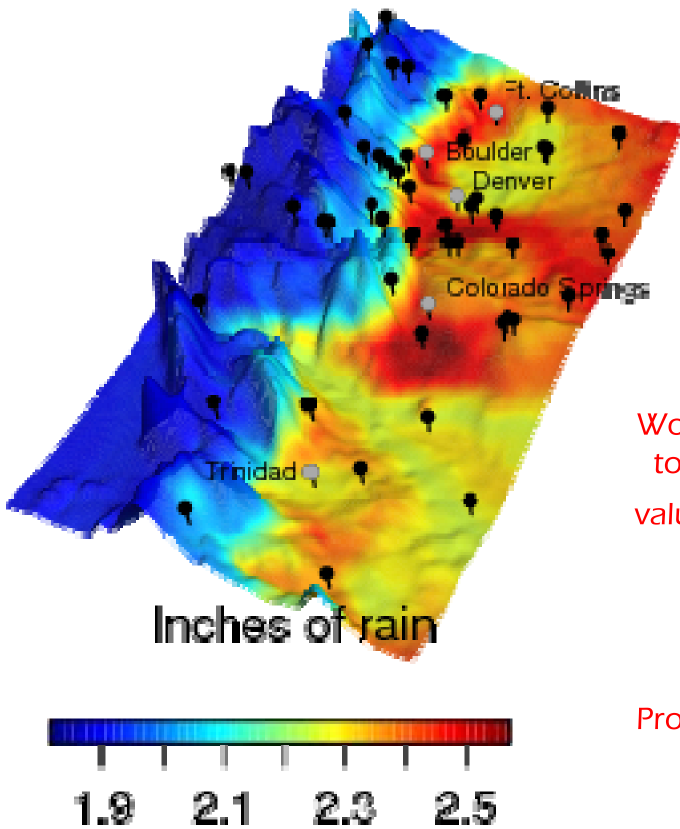
Graybill VIII/EVA2009

The Department of Statistics at Colorado State University proudly hosts the

6th International Conference on Extreme Value Analysis

June 22-26, 2009 Fort Collins, Colorado USA



June 22

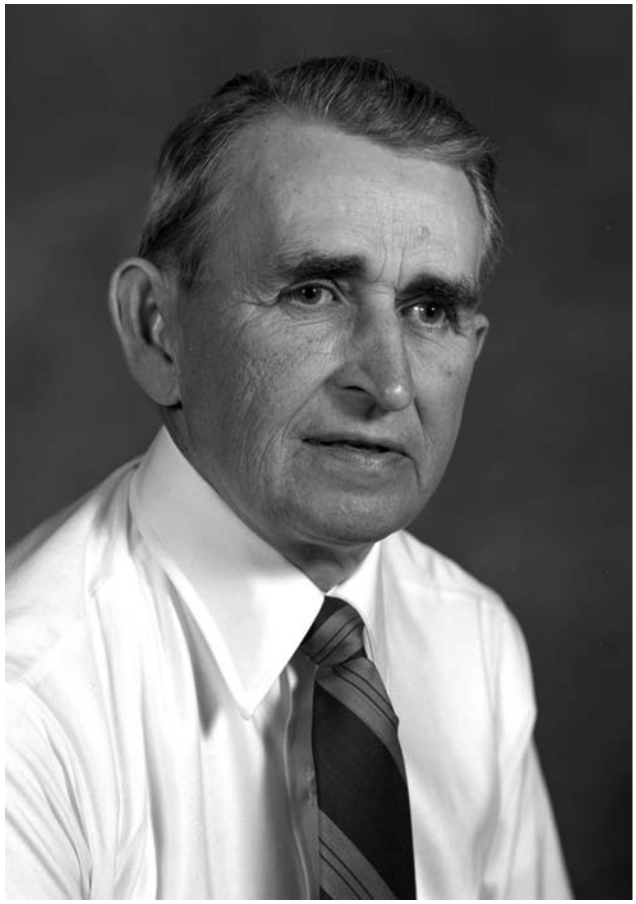
Workshop: An introduction to the analysis of extreme values using R and extRemes

June 23-26

EVA2009 Conference

Program will consist of both invited sessions and contributed talks

Colorado State University



PROFESSOR FRANKLIN A. GRAYBILL

Department of Statistics
Colorado State University

Foreword

The Department of Statistics at Colorado State University is pleased to host "Graybill Conference VIII" during June 22-26, 2009. This year's conference doubles as the 6th International Meeting on Extreme Value Analysis (EVA) and its Applications. Our sincere thanks to all the keynote and invited speakers, the instructors for the short courses, and the poster presenters for their participation in this conference.

Jay Breidt

Department of Statistics

Colorado State University

June 2009

Past Conferences:

Graybill Conference 2001 – June 13-15

Inaugural Graybill Conference on Linear, Nonlinear, and Generalized Linear Models

Organizers: Hari Iyer & Jim zumBrunnen

Graybill Conference 2003 – June 18-20

Microarrays, Bioinformatics, and Related Topics

Organizers: Hari Iyer & Jim zumBrunnen

Short course on "Microarray Data Analysis" by Dr. Steen Knudsen

Graybill Conference 2004 – June 16-18

Spatial Statistics: Agricultural, Ecological & Environmental Applications

Program Chair: Scott Urquhart

Short Course on "Applied Spatial Statistics" by Dr. Jay Ver Hoef

Graybill Conference 2005 – June 1-2

Statistics in Information Technology

Program Committee: Bin Yu (Chair), Thomas Lee (Co-Chair), Mark Hansen, and Hari Iyer

Short Course on "Minimum Description Length" by Professors Bin Yu and Mark Hansen

Graybill Conference 2006 – June 11-13

Multi-scale methods and Statistics – A Productive Marriage

Program Committee: Thomas Lee (Chair), Xiao-Li Meng, and Patrick Wolfe

Short Course on "Multiscale methods" by Professors Xiao-li Meng, Patrick Wolfe, and Thomas Lee

Graybill Conference 2007 – June 12-15

A Workshop on Bioinformatics and a Symposium on Applied Probability
and Time Series in honor of Professor Peter J. Brockwell.

Program Committee: Duane Boes (honorary chair), Richard Davis, Jay Breidt, Asa Ben-Hur, and Hari Iyer

Short Course on BLAST by Professor Warren Ewens

Graybill Conference 2008 –June 11-13

Biopharmaceutical Statistics

Program Committee: Alfred Balch, Scott Evans, Brian Wiens, and Jim Whitmore

Short Course on Hot Topics in Clinical Trials by Professors L.J. Wei, Marvin Zelen, Scott
Evans and Lingling Li, Harvard University

Conference Co-Chairs:

Dan Cooley (Colorado State University)

Richard Davis (Columbia University)

Philippe Naveau (LSCE/IPSL)

Program Committee:

Dan Cooley (Colorado State University)

Richard Davis (Columbia University)

Paul Embrechts (ETH)

Anne-Laure Fougères (Université Lyon)

Ivette Gomes (University of Lisbon)

Jürg Hüsler (University of Bern)

Rick Katz (NCAR)

Claudia Klüppelberg (Munich University of Technology

Thomas Mikosch (University of Copenhagen)

Philippe Naveau (LSCE/IPSL)

Liang Peng (George Tech)

Holger Rootzén (Chalmers University)

Local Organization

Dan Cooley (Colorado State University)

Jim zumBrunnen (Colorado State University)

Kristin Chatnani (Colorado State University)

CSU Graduate Student Volunteers

Derek Sonderegger
Bruce Bugbee
Amber Hacksta
Grant Weller
Joshua French
Ryan Koralik

Peter DeWitt
Huan Wang
Brett Hunter
Ben Bird
Yuan Wang

The following graduates of the Department of Statistics at Colorado State University completed their degrees under the guidance of Professor Franklin A. Graybill:

Mohamed H. Albohali (MS '79)
Robert A. Ahlbrandt (MS '87)
Carmen E. Arteaga (MS '80)
James H. Baylis (MS '77)
David C. Bowden (MS '65, PhD '68)
Brent D. Burch (MS '93, PhD '96)
James A. Calvin (PhD '85)
Terrence L. Connell (MS '63, PhD '66)
Ruth Ann Daniel (MS '80)
Ali Mashat Deeb (MS '81)
Richard M. Engeman (MS '75)
Rana S. Fayyad (PhD '95)
Mark J. Grassl (MS '80)
Rongde Gui (PhD '92)
Paul A. Hatab (MS '77)
William C. Heiny (MS '81)
Sakthivel Jeyaratnam (PhD '78)
Dallas E. Johnson (PhD '71)
Thomas A. Jones (MS '67)
Yongsang Ju (MS '92)
Adam Kahn (MS '78)
M. Kazem Kazempour (PhD '88)
Albert Kingman (PhD '69)
Stephen L. Kozarich (PhD '71)
Ricardo A. Leiva (MS '82)
Tai-Fang Chen Lu (MS '79, PhD '85)
Sandra Mader (MS '77)
Farooq Maqsood (MS '84)
Louise R. Meiman (MS '67)
Ronald R. Miller (MS '76)
George A. Milliken (MS '68, PhD '69)
Michael E. Mosier (PhD '92)
William B. Owen (PhD '65)
Antonio Reverter-Gomez (MS '94)
Robert C. Rounding (PhD '65)
Bhabesh Sen (PhD '88)
Jeanne Simpson (MS '78)
Syamala Srinivasan (MS '84, PhD '86)
R. Kirk Steinhorst (MS '69, PhD '71)
Naitee Ting (PhD '87)
N. Scott Urquhart (MS '63)
Antonia Wang (MS '82)
Chih-Ming (Jack) Wang (PhD '78)

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EVA 2009/Graybill Conference VIII

PROGRAM

June 22-26, 2008

Colorado State University and Hilton Fort Collins, Fort Collins, CO

Monday, June 22, 2009

Colorado State University Campus

8:00-9:00 AM	**Registration**	**Hilton Pre-Convention Area**
9:00 AM to 12:00 PM & 1:00 PM to 4:00 PM		**CSU Weber Building room 205**

An Introduction to the analysis of extreme values using R and extRemes

Eric Gilleland, NCAR, Boulder, CO and Mathieu Ribatet, EPFL, Lausanne, Switzerland

Much of the statistical analysis tools taught in introductory statistics courses concern with the center of mass of distributions, often relying on the Central Limit Theorem (CLT) as justification for assuming that a sample of data follow the Normal distribution. When interest is in extremes, however, much of the data can be less useful, and the assumption of normality may not be appropriate. A similar theorem to the CLT, the Extremal Types Theorem, provides justification for the generalized extreme value (GEV) family of distributions under certain assumptions.

This workshop will give some background on extreme value analysis (EVA), and an introduction to fitting data to the GEV as well as threshold excess models (the generalized Pareto (GP) and point process). The R programming language will be used, but no knowledge of the language is required as the graphical user interface (GUI) R package, extRemes, will primarily be used. Some instruction on using R will also be given to assist in going beyond the capabilities of the GUI's.

In addition to the introduction to statistical analysis of extremes, the workshop will present a **tutorial on spatial extremes** using the spatial extremes package in R.

6:00-9:00 PM	**Registration**	**Hilton Pre-Convention Area**
7:00 to 9:00 PM	**Opening Mixer**	**Hilton Salon II**

Tuesday, June 23, 2009
Hilton Fort Collins

6:30-8:30 Continental Breakfast **Hilton Atrium**

7:30AM –6:00 PM Registration /Poster Set-up **Hilton Pre-Convention Area**

8:30-9:00 Welcoming Remarks **Hilton Salon I**

9:00-10:30 Session 1 **Hilton Salon I**
Invited Session: Functional extremes
Chair: Gena Samorodnitsky
Organizer: Henrik Hult
Henrik Hult On Importance Sampling for Calculating Risk Measures-The Heavy Tailed Case

Filip Lindskog Ruin Probabilities Under General Investments and Heavy-Tailed Claims

Thomas Mikosch The Maximum Increment of a Heavy-Tailed Random Walk

10:30-11:00 Break **Hilton Atrium**

11:00-12:30 Session 2 **Hilton Salon I**
Invited Session: Spatial extremes
Chair: Phillipe Naveau
Organizer: A. Davison
Anthony Davison Geostatistics Of Extremes

Mathieu Ribatet Inferential procedures for max-stable processes

Huiyan Sang Continuous Spatial Process Models for Spatial Extreme Values

12:30-2:00 Lunch/Posters **Hilton Atrium**

2:00-3:00 Session 3A **Hilton Salon I**
Special Contributed Session: Topics in Extremes
Chair: Laurens de Haan
Goedele Dierckx Change point analysis of extreme values

Michael Falk A Multivariate Piecing-Together Approach

Jonathan Hosking Frequency Estimation Of Rare Events By Adaptive Thresholding

2:00-3:00 Session 3B **Hilton Salon II**
Contributed Session: Applied Probablility/Time Series (A)
Chair: Sidney Resnick
Arijit Chakrabarty Effect of Truncation on Heavy-tailed Models

Changryong Baek Second order properties of distribution tails and estimation of tail exponents in random difference equations

Martin Moser Tail Behavior Of Multivariate L_Evy Driven Mixed Moving Average Processes

Luis Lopez-Oliveros Statistical Analysis Of Network Sessions

Tuesday, June 23, 2009 continued
Hilton Fort Collins

3:00-4:00 Session 4A **Hilton Salon I**
Contributed Session: Distribution and Limit Theory
Chair: Zhengjun Zhang

Anne Feidt Asymptotics and Poisson approximation of joint maxima for discrete random variables

Melanie Frick Limiting Distributions of Maxima in Triangular Schemes

Pavle Mladenovic Limit Distributions In Certain Limit Theorems For Extreme Values And Rates Of Convergence

Dmitrii Zhould Extremes Of Student's T-Statistics For Non-Normal And Not Necessarily I.I.D. Random Variables

3:00-4:00 Session 4B **Hilton Salon II**
Contributed Session: Spatial Extremes
Chair: Rick Katz

Thomas Meinguet Heavy Tailed Functional Data Analysis

Caroline Keef Spatially aggregated flood risk estimates

Pasquale Cirillo An urn-based spatio-temporal shock model

Liliane Bel Testing for spatial asymptotic independence using the madogram function

4:00-4:30 Break **Hilton Atrium**

4:30-6:00 Session 5 Invited Session:
Measures of dependence for multivariate extremes **Hilton Salon I**
Organizer and Chair: Anne-Laure Fougeres

Sidney Resnick The Conditional Extreme Value Model And Data Network Sessions

Philippe Soulier The Tail Empirical Process Of Some Long Memory Processes

Zhengjun Zhang On the Estimation and Application of Max-Stable Processes

6:00-7:00 Poster Session **Hilton Salon II**

Julie Carreau Modelling A Bivariate Distribution With Heavy Tails

Andree Ehlert A New Perspective on Extremal Dependence: The Example of GARCH Processes

Daniel Gembris Evolution Of Athletic Records: Statistical Effects Versus Real Improvements

Raphael Huser On kriging of extreme precipitation return levels and tapering

Agnieszka Jach Wavelet estimation of heavy tails

Manuela Neves A Computational Diagnostic For The Threshold In The Extremal Index Estimation

Simone Padoan Modelling of Spatial Extremes: A Review

Paula Reis Ultimate and penultimate models for the reliability of regular and homogeneous series-parallel systems

Erin Schliep Spatial Hierarchical Modeling in Comparing Extreme Precipitation Generated by Regional Climate Models

Elizabeth Shamseldin Severe Weather under a Changing Climate: Large Scale Indicators of Extreme Events

Wednesday, June 24, 2009
Colorado State University Campus

6:30-8:30 Continental Breakfast — **Hilton Atrium**

7:30 – 8:00 Registration — **Hilton Pre-Convention Area**

8:30-10:00 Session 6 — **CSU Natural Resources room 113**

Invited Session: Extremes of time series
Organizer and Chair: Johan Segers
Holger Drees Empirical processes at work: statistical analysis of extremal serial dependence

Alexander Lindner Extremes of Autoregressive Threshold Processes

David Walshaw Bias In Return Level Estimation Incurred By Peaks-Over-Threshold Analyses

10:00-10:30 Break — **CSU Natural Resources Atrium**

10:30-12:00 Session 7 — **CSU Natural Resources room 113**
Invited Session: Statistics for Extremes
Chair: Holger Rootzen
Organizer: M. Ivette Gomes
Armelle Guillou Goodness-Of-Fit Testing for Weibull-Type Behavior
Stilian Stoev On the structure of max–stable processes

M. Ivette Gomes A Quasi-Port Methodology For Var: Second-Order Reduced-Bias Estimation

12:00-1:00 Registration — **Hilton Pre-Convention Area**

12:00 Box Lunches available in Atrium (Hilton Fort Collins)

12:40 Excursion - Rocky Mountain National Park — **Buses Depart from Hilton (West Door)**

Buses will drive into Rocky Mountain National Park and stop at Bear Lake where there are numerous hiking trails. You will have two hours to hike around the Bear Lake area, then buses will take you into downtown Estes Park for dinner where you can choose from a number of restaurants. We will bring water bottles on the bus. It is suggested that you bring sunscreen, good walking shoes, extra water (if desired), your camera and clothing for variable conditions (warm, cool, wet, sunny).

3:00 Buses arrive at Bear Lake

5:00 Buses leave for Estes Park

6:00-8:00 Dinner in Estes Park

8:30 Buses leave Estes Park

9:30 p.m. Approximate return to Hilton, Fort Collins

Thursday, June 25, 2009
Colorado State University Campus

6:30-8:30 Continental Breakfast **Hilton Atrium**

7:30 -9:00 Registration Hours **Hilton Pre-Convention Area**

8:30-10:00 Session 8 **CSU Natural Resources room 113**
Invited Session: Gaussian Processes
Chair: Holger Drees
Organizer: Juerg Husler
Mario Wschebor Second order approximation of the tail of the distribution of the maximum of a Gaussian process

Jean Marc Azais Confidence Bounds for Curve Prediction Using the Distribution of the Maximum of Gaussian Processes

Juerg Husler Recent results on extremes of Gaussian processes

10:00-10:30 Break **CSU Natural Resources Atrium**

10:30-12:00 Session 9A **CSU Natural Resources room 113**
Invited Session: Large Deviations
Chair: Thomas Mikosch
Organizer: Gena Samorodnitsky
Souvik Ghosh Large Deviation Principle for a Class of Long Range Dependent Infinitely Divisible Process
Ton Dieker Large Deviations for Random Walks under Subexponentiality: The Big-Jump Domain
Gennady Samorodnitsky Geometric Characteristics of the Excursion Sets over High Levels of non-Gaussian Infinitely divisible Random Fields

10:30-12:00 Session 9B **CSU Glover room 130**
Contributed Session: Multivariate Dependence and Copulas
Chair: Juerg Huesler
Natalia Lysenko Asymptotic independence of the components for random vectors from unimodal densities

Abhimanyu Mitra Aggregation of Rapidly Varying Risks and Asymptotic Independence

Xiao Qin Modelling Multivariate Joint Tails and a New Class of Bivariate Survival Functions

Martin Larsson Tail Properties of Multivariate Archimedean Copulas

Lena Reh Multivariate Tail Dependence Measures for Archimedean Copulas

Bikramjit Das Conditional extreme value models: Characterization and detection techniques

12:00-1:30 Lunch **CSU Lory Student Center**
Lunch cards will be distributed at the end of session 9A&9B

Thursday, June 25, 2009
Colorado State University Campus

1:30-2:30 Session 10A **CSU Natural Resources room 113**
Special Contributed Session: Extremes at NCAR
Chair: Dan Cooley

Rick Katz Statistical Modeling of Hot Spells And Heat Waves

Eric Gilleland Extreme behavior of large scale indicators for severe weather

Stephan Sain Regional Climate, NARCCAP, and Heat Waves

1:30-2:30 Session 10B **CSU Glover room 130**
Contributed Session: Applied Probability/Time Series (B)
Chair: Filip Lindskog

Olivier Wintenberger Infinite variance stable limits for sums of dependent random variables

Marta Ferreira Modeling rare events through a pRARMAX process

Jeffrey Collamore On Precise Estimates For a Class Of Random Recurrence Equations

Anja Janssen On Some Extremal Characteristics of GARCH Processes

2:30-3:45 Session 11A **CSU Natural Resources room 113**
Contributed Session: Climate/Weather
Chair: Anthony Davison

Juliet Blanchet Max-stable model for climate extremes. Application to extreme snow depth in the Swiss Alps

Federico Garavaglia Interest of rainfall probabilistic model based on atmospheric circulation patterns

Thomas Jagger Modeling hurricane winds with quantile regression

Gabriel Huerta Time Varying Structures for Extreme Values

Thi Thu Huong Hoang Multidimensional trends and extremes with application to temperatures in Europe

2:30-3:45 Session 11B **CSU Glover room 130**
Contributed Session: Gaussian Models, Level Curves, and Related Properties
Chair: Jay Breidt

Troy Butler Computational Measure-Theoretic Method for Posterior Density Estimation

Alexandre Lekina Extreme Level Curves of Heavy-Tailed Distributions

Anastassia Baxevani Spatio-Temporal Gaussian Models and their level crossings distributions

Joshua French Confidence Regions for Level Curves

Damian Wandler Fiducial Inference on the Maximum Mean of a Multivariate Normal Distribution

3:45-4:15 Break **CSU Natural Resources Atrium**

Thursday, June 25, 2009
Colorado State University Campus

4:15-6:15 Session 12 **CSU Natural Resources room 113**
Invited Session: Geosciences and Climate
Organizer and Chair: Richard Smith
Francis Zwiers Assessing Human Influence on Extremes

Xuebin Zhang The influence of large scale climate variability on winter maximum daily precipitation over North America

Montse Fuentes Nonparametric Spatial Models for Extreme Temperature Data.
Richard Smith, Discussant

6:00-9:00 Registration **Hilton Pre-Convention Area**

6:30-9:00 Cash Bar **Hilton Pre-Convention Area**

7:00-9:00 Banquet **Hilton Salon II**

Speaker: Paul Embrechts "Did a mathematical formula really blow up Wall Street?".

Friday, June 25, 2009
Hilton Fort Collins

6:30-8:30 Continental Breakfast — **Hilton Atrium**

7:30 AM-5:30 PM Registration — **Hilton Pre-Convention Area**

8:30-10:00 Session 13 — **Hilton Salon I**
Invited Session: Empirical processes
Organizer and Chair: J. Einmahl
Holger Rootzen Limit Theorems for Empirical Processes of Cluster Functionals

Johan Segers Inference on Copulas: When Ignorance is Bliss
Andrea Krajina An M-Estimator of Tail Dependence in Arbitrary Dimensions

10:00-10:30 Break — **Hilton Atrium**

10:30-12:00 Session 14A — **Hilton Salon I**
Invited Session: Risks, Finance and Insurance
Chair: Peter Brockwell
Organizer: Claudia Klüppelberg
John Nolan Models for dependent extremes using stable mixtures

Vicky Fasen Cointegration in continous-time with applications in finance

Robert Stelzer The Multivariate Ornstein-Uhlenbeck Type Stochastic Volatility Model and Its Tail Behaviour

10:30-12:00 Session 14B — **Hilton Salon II**
Contributed Session: Statistics of Extremes
Chair: Phillipe Soulier
Yun Gong Coverage Accuracy For a Mean Without Third Moment

Parthanil Roy Hill Estimator For Tempered Power Laws

Diana Tichy Representation of the Fragility Index by norms

Stephane Girard A Unified Statistical Model For Pareto And Weibull Tail Distributions

Wei-han Liu Detecting Structural Breaks in Tail Behavior From the Perspective of Fitting the Generalized Pareto Distribution

Qihe Tang The Tail Probability of Stochastically Discounted Aggregate Claims with Subexponential Tails

12:00-1:30 Lunch — **Hilton Atrium**

Friday, June 25, 2009
Hilton Fort Collins

1:30-3:00 Session 15A **Hilton Salon I**
Invited Session: Simulation of rare events
Chair: Henrik Hult
Organizer: J. Blanchett
Sergey Foss Rare events in tandems of queues with heavy-tailed distributions

Jingchen Liu Rare-event Simulation for Gaussian Random Fields

Jose Blanchett Rare-event Simulation Techniques

1:30-3:00 Session 15B **Hilton Salon II**

Contributed Session: Finance and Risk
Chair: Paul Embrechts
Mark Labovitz Using Time Varying Extreme Value Models In The Construction of A Financial Factor Model

Dominik Lambrigger Risk Concentration of Extreme Events Under Second-Order Regular Variation

Mohamed Ammezziane Probabilistic and Statistical Poperties of Even B-Splines Distributions

and Their Applications in Financial Modeling

Matthias Degen The Use of Penultimate Approximations in Risk Management

Annabelle Kehl Market Risk – Parametrization and Estimation in a General Pareto Model with Time Varying Thresholds

Robert Rimmer Modeling Financial Market Returns With A Lognormally Scaled Stable Distribution

3:00-3:30 Break **Hilton Atrium**

3:30-5:00 Session 16 Univariate, Multivariate and Infinite Extremes **Hilton Salon I**
Chair: Ivette Gomes
Organizer: Liang Peng
Deyuan Li Bias Reduction for Endpoint Estimation

John Einmahl Estimating Extreme Quantile Regions For Two Dependent Risks

L. de Haan On Estimating Extreme Tail Probabilities of The Integral of a Stochastic Process

5:00 Closing Remarks **Hilton Salon I**

Late Afternoon Snack **Hilton Atrium**

Abstracts

Tuesday, June 23

9:00-10:30 Session 1

ON IMPORTANCE SAMPLING FOR CALCULATING RISK MEASURES – THE HEAVY-TAILED CASE

HULT, HENRIK (speaker) KTH, Stockholm, hult@kth.se

SVENSSON, JENS KTH, Stockholm

Importance sampling; Regular variation; Large deviations; Risk measures:

We propose efficient simulation algorithms based on importance sampling for calculating risk measures (e.g. Valueat-Risk and Expected Shortfall) at high quantiles. We show that the design of efficient algorithms for calculating risk measures is closely related to those for estimating rare event probabilities. For illustration we consider a random walk with heavy-tailed steps (in the sense of regular variation).

RUIN PROBABILITIES UNDER GENERAL INVESTMENTS AND HEAVY-TAILED CLAIMS

LINDSKOG, FILIP (speaker) KTH, Sweden, lindskog@kth.se

HENRIK HULT KTH, Sweden

Regular variation; Semimartingales; Ruin probabilities; Stochastic control:

In this paper we study the asymptotic decay of finite time ruin probabilities for an insurance company that faces heavy-tailed claims, uses predictable investment strategies and makes investments in risky assets whose prices evolve according to quite general semimartingales. We show that the ruin problem corresponds to determining hitting probabilities for the solution to a randomly perturbed stochastic integral equation. We derive a large deviation result for the hitting probabilities that holds uniformly over a family of semimartingales and show that this result gives the asymptotic decay of finite time ruin probabilities under arbitrary investment strategies, including optimal investment strategies.

References

[1] Hult, H., Lindskog, F. (2008) Ruin probabilties under general investments and heavy-tailed claims, Preprint, arXiv:0809.4372v1 [math.PR].

THE MAXIMUM INCREMENT OF A HEAVY-TAILED RANDOM WALK

MIKOSCH, THOMAS (speaker) University of Copenhagen, Denmark, mikosch@math.ku.dk

ALFREDAS RACKAUSKAS Vilnius, Lithuania

We deal with the asymptotic distribution of the maximum increment of a random walk with heavy-tailed step sizes in the sense that their distribution is regularly varying. This problem is motivated by a long-standing problem on change point detection for epidemic alternatives. It turns out that the limit distribution of the maximum increment of the random walk is one of the classical extreme value dsitributions, the Frechet distribution. We prove the results in the general framework of point processes and for step sizes taking values in a separable Banach space.

Tuesday, June 23

11:00-12:30 Session 2

Geostatistics of extremes

Davison, Anthony EPFL, 1015 Lausanne, Switzerland, Anthony.Davison@epfl.ch

Gholamrezaee, M. Mehdi EPFL, 1015 Lausanne, Switzerland

Composite likelihood; Max-stable process; Spatial statistics; Temperature data:

We describe an approach to flexible modelling for extremes of processes observed at points in space, fitting maxstable processes derived from underlying Gaussian geostatistical models. Estimation, model comparison and fitting are performed by composite likelihood inference. An example is given concerning annual maximum temperatures over 46 years at sites in Switzerland.

Inferential procedures for max-stable processes

Mathieu RIBATET École Polytechnique Fédérale de Lausanne, Switzerland, mathieu.ribatet@epfl.ch

Dan COOLEY Colorado State University, USA

Anthony DAVISON École Polytechnique Fédérale de Lausanne, Switzerland

Composite likelihood; Metropolis–Hastings; Likelihood theory:

The last decade has seen max-stable processes emerge as a common tool for the statistical modelling of spatial extremes. However, their application is complicated due to the unavailability of the multivariate density function, and so likelihood-based methods remain far from providing a complete and flexible framework for inference. In this talk we develop inferentially practical, likelihood-based methods for fitting max-stable processes derived from a composite-likelihood approach. The procedure is sufficiently reliable and versatile to permit the simultaneous modelling of marginal and dependence parameters in the spatial context at a moderate computational cost. The utility of this methodology is examined via simulation, and illustrated by the analysis of U.S. precipitation extremes. In addition, an attempt towards bayesian inference for max-stable processes is presented. Although in frequentist analysis, the maximum composite likelihood estimator is easily workable as it shares similar asymptotic properties than the maximum likelihood estimator; its use in Bayesian inferences is not straightforward. More precisely, by using the Metropolis–Hastings algorithm as it is, this will lead to composite posterior distributions and one looses all the assets of a Bayesian analysis. In this talk, two methodologies for adjusting the M.-H. algorithm when composite likelihoods are involved are presented. These approaches aim to adjust the acceptance probability within the M.-H. algorithm based on asymptotic arguments. An application on a toy example is given.

References

[1] Chandler, R. E., Bate, S. (2007) Inference for clustered data using the independence loglikelihood., Biometrika, 94(1):167–183.

[2] Cooley, D., Nychka, D. and Naveau, P. (2007). Bayesian spatial modeling of extreme precipitation return levels., Journal of the American Statistical Association, 102:824–840.

[3] Kent, J. (1982) Robust properties of likelihood ratio tests., Biometrika, 69:19–27.

[4] Lindsay, B. (1988) Composite likelihood methods., Statistical Inference from Stochastic Processes. American Mathematical Society, Providence.

[5] Padoan, S. A., Ribatet, M. and Sisson, S. A. (2009) Likelihood-based inferences for max-stable processes, Submitted to the Journal of the American Statistical Association.

11:00-12:30 Session 2 continued

6] Ribatet, M. (2009) A user's guide to the SpatialExtremes package Available as a part of the package or at the package web page.

[7] Rotnitzky, A.n Jewell, N. (1990) Hypothesis testing of regression parameters in semiparametric generalized linear models for cluster correlated data., Biometrika, 77:495–497.

[8] Schlather, M. (2002). Models for stationary max-stable random fields Extremes, 5(1):33–44.

[9] Smith, R. (1991). Max-stable processes and spatial extreme Unpublished manuscript.

Continuous Spatial Process Models for Spatial Extreme Values

Sang, Huiyan *Texas A&M University, USA*, huiyan@stat.tamu.edu

Gelfand, Alan E. *Duke University, USA*

Copula Gaussian process models; generalized extreme value distribution; maximum precipitation surfaces; spatial interpolation.

We propose a hierarchical modeling approach for explaining a collection of point-referenced extreme values. In particular, annual maxima over space and time are assumed to follow Generalized Extreme Value (GEV) distributions, with parameters ¹, ¾ and », speci¯ed in the latent stage to re°ect underlying spatio-temporal structure. The novelty here is that we relax the conditionally independence assumption in the ¯rst stage of the hierarchial model which has been adopted in previous work. We o®er a spatial process model for extreme values which provides mean square continuous realizations, where the behavior of the surface is driven by the spatial dependence which is unexplained under the latent spatio-temporal speci¯cation for the GEV parameters. A simulation study and a study on actual annual maximum rainfalls for a region in South Africa are used to illustrate the performance of the model.

2:00-3:00 Session 3A

Change point analysis of extreme values

Dierckx, Goedele Hogeschool Universiteit Brussel, Katholieke Universiteit Leuven, Belgium, Goedele.Dierckx@wis.kuleuven.be

Teugels, J.L. Katholieke Universiteit Leuven, Belgium and Eurandom, The Netherlands

Change point analysis; extreme value theory; extreme value index; Generalized Pareto Distribution; maximum likelihood:

In a sample from the distribution of a random variable, it is possible that the tail behavior of the distribution changes at some point in the sample. This tail behavior can be described by absolute or relative excesses of the data over a high threshold, given that the random variable exceeds the threshold. The limit distribution of the absolute excesses is given by a Generalized Pareto Distribution with an extremal parameter and a scale parameter . When the extreme value index is positive, then the relative excesses can be described in the limit by a Pareto distribution with this index as parameter.

We concentrate on testing whether changes occur in the value of the extreme value index and/or the scale parameter. To this end, appropriate test statistics are introduced based on the likelihood approach of Csörgo and Horváth (1997) for independent data. Asymptotic properties of these test statistics are studied leading to adequate critical values. After giving a practical test procedure, we apply our results to a series of simulations and real life examples.

References

[1] Csörgo, M., Horváth, L. (1997) Limit Theorems in Change Point Analysis, Wiley, Chichester.

Tuesday, June 23

2:00-3:00 Session 3A continued

A MULTIVARIATE PIECING-TOGETHER APPROACH

FALK, MICHAEL (speaker) University of Wuerzburg, Germany,
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Stefan Aulbach University of Wuerzburg, Germany

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Multivariate extreme value distribution; multivariate generalized Pareto distribution; Peaks-Over-Threshold; Piecing-Together:

The univariate Piecing-Together approach fits a univariate generalized Pareto distribution to the upper tail of a given distribution function in a continuous manner. We propose a multivariate extension.
When applied to data, this approach enables also in the multivariate case the estimation of probabilities of sets in the upper tail of a distribution which contain no data, i.e., of rare events.

FREQUENCY ESTIMATION OF RARE EVENTS BY ADAPTIVE THRESHOLDING

J. R. M. HOSKING (speaker) IBM Research Division, U.S.A., hosking@watson.ibm.com

STEPHEN HEISIG IBM Research Division, U.S.A.

Extreme values; Generalized Pareto; L-moments; Business Applications:

In many industrial applications there is a need to estimate, from a set of observations of some physical quantity, the observation magnitude that will be exceeded with some specified extremely small probability. We describe an approach that fits a generalized Pareto distribution to the m largest events, for a range of values of m, designates one of these values of m as “best", and estimates extreme quantiles based on these m observations. We reduce the bias of quantile estimates by choosing m so that the chosen subsample is consistent with all smaller subsamples in terms of the estimated tail index. To maintain accuracy when the assumed probability distribution is incorrect, subsamples that fail a goodness-of-fit test are ignored when evaluating consistency of one subsample with smaller subsamples. The method is illustrated using data on transaction times in an online banking application.

2:00-3:00 Session 3B

Effect of truncation on heavy-tailed models

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Samorodnitsky, Gennady Cornell University, U.S.A.

heavy-tailed distributions; large deviations; central limit theorem:

There are lot of situations where heavy-tailed models have proven to be a good fit, and at the same time there is a natural upper bound on the possible values, and hence the need to study truncated heavy-tailed models. This talk is on understanding such models. It turns out that depending upon on the truncation level and the tail, one can differentiate between two regimes. To be specific, the difference between the two regimes shows up in the central limit behaviour and the decay rate of large deviation prbabilities. The second part of the talk is on the statistical problem of deciding the truncation regime from data.

Tuesday, June 23

2:00-3:00 Session 3B

Second order properties of distribution tails and estimation of tail exponents in random difference equations

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random difference equations; tail exponent and its estimation; second order regular variation; ARCH models :
According to a celebrated result of Kesten (Acta Math 131:207. 248, 1973), random difference equations have a power-law distribution tail in the asymptotic sense. Empirical evidence shows that classical estimators of tail exponent of random difference equations, such as Hill estimator, are extremely biased for larger values of tail exponents. It is argued in this work that the bias occurs because the power-tail region is too far in the tail from a practical perspective. This is supported by analyzing a few examples where a stationary distribution of random difference equation is known explicitly, and by proving a weaker form of the so-called second order regular variation of distribution tails of random difference equations, which measures deviations from the asymptotic power tail. To reduce bias, several least squares estimators, generalizing rank-based and QQ-estimators, and conditional maximum likelihood estimators, based on the exact form of second order regular variation, are introduced and the their basic asymptotics are established. Numerical performance of proposed estimators is examined through Monte Carlo simulations. ARCH models of interest in Finance and multiplicative cascades used in Physics are considered as motivating examples throughout the work. Extension to multidimensional random difference equations with nonnegative entries is also considered.

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Tuesday, June 23

2:00-3:00 Session 3B

TAIL BEHAVIOR OF MULTIVARIATE LÉVY DRIVEN MIXED MOVING AVERAGE PROCESSES

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Stelzer, Robert *Technische Universität München, Germany*

Infinitely Divisible Independently Scattered Random Measures; Lévy Basis; Multivariate Moving Average Processes; Regular Variation; Tail Behavior;

In this talk we consider the tail behavior of mixed moving average (MA) processes, which are driven by regularly varying Lévy bases. An R^d-valued Lévy basis or infinitely divisible independently scattered random measure (i.d.i.s.r.m.) $\Lambda = (\Lambda(B))_{B \in \mathcal{B}_b(M_d^- \times R)}$ on $\mathcal{B}_b(M_d^- \times R)$ (where M_d^- is the set of all $d \times d$ matrices whose eigenvalues have negative real part) is characterized by the following properties: The distribution of $\Lambda(B)$ is infinitely divisible for all $B \in \mathcal{B}_b(M_d^- \times R)$, for any n the random variables $\Lambda(B_1), \ldots, \Lambda(B_n)$ are independent for pairwise disjoint sets $B_1, \ldots, B_n \in \mathcal{B}_b(M_d^- \times R)$ and for any pairwise disjoint sets $(B_i)_{i \in N}$ with $\bigcup_{n \in N} B_n \in \mathcal{B}_b(M_d^- \times R)$ we have $\Lambda(\bigcup_{n \in N} B_n) = \sum_{n=1}^{\infty} \Lambda(B_n)$ almost surely.
Lévy driven mixed MA processes are multivariate stochastic processes of the form

$$X_t := \int_{M_d^-} \int_{-\infty}^{t} f(A, t-s) \; \Lambda(dA, ds)$$

with $f : M_d^- \times R \mapsto M_d$ and we concentrate on the case when the integral is stationary and exists as a limit in probability for all $t \in R_+$. The tail behavior of X_t in the univariate case has already been studied in [1]. The aim of this talk is to extend the results to the multivariate setting.
Using results of [2], we will prove regular variation of X_t, given the Lévy measure of Λ is regularly varying and certain conditions for the function f hold. As a special example we consider supOU processes given by

$$f(A, t-s) = e^{A(t-s)}.$$

These processes are especially relevant in stochastic volatility modelling with long memory.

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Tuesday, June 23

2:00-3:00 Session 3B

STATISTICAL ANALYSIS OF NETWORK SESSIONS

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RESNICK, SIDNEY *Cornell University, United States*

Network modeling; peak transmission rate; heavy tails; regular variation; spectral measure:

Statistics on data networks show empirical features that are surprising by the standards of classical queueing theory. Two distinctive properties are: (i) Heavy tails for file sizes ([1], [4], [8], [9]), transmission durations and transmission delays ([5], [6]); (ii) Network traffic is bursty ([7]), with rare but influential periods of high transmission rate punctuating typical periods of modest activity. Burstiness is important in order to understand congestion.

We refine a stimulating study by [7] which highlighted the influence of peak transmission rate on network burstiness. From TCP packet headers, we amalgamate packets into sessions where each session is characterized by a 5-tuple (size $(S, D, R, R^{\vee}, \Gamma)$=(total payload, duration, average transmission rate, peak transmission rate, initiation time). After careful consideration, a new definition of peak rate is required. Unlike [7] who segmented sessions into two groups labelled alpha and beta, we segment into 10 sessions according to the empirical quantiles of the peak rate variable as a demonstration that the beta group is far from homogeneous. Our more refined segmentation reveals additional structure that is missed by segmentation into two groups. In each segment, we study the dependence structure of (S, D, R). We find that the dependence structure of each pair (S, D), (R, S) and (R, D) varies across the groups. We also review and use methods that are more suitable than correlation in the context of heavy tailed-modeling for studying the dependence of two variables, such as the concept of spectral measure that arises in the characterization of multivariate regular variation using the polar coordinate transformation ([2], [3]).

Furthermore, within each segment, the session initiation time is well approximated by a Poisson process whereas this property does not hold for the data set taken as a whole. Therefore, we conclude that the peak rate level is important for understanding structure and for constructing accurate simulations of data in the wild. We outline a simple method of simulating network traffic based on our findings.

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Tuesday, June 23

3:00-4:00 Session 4A

Asymptotics and Poisson approximation of joint maxima for discrete random variables

Feidt, Anne (speaker) University of Zurich, Switzerland, anne.feidt@math.uzh.ch

Discrete distributions; joint extremes; maximum; copula; Poisson approximation; Stein-Chen method; approximation errors:

We show that the asymptotic extremal behavior of discrete random vectors is characterized by the weak limit of its suitably normalized components and the convergence of any compatible copula, as is the case for continuous random vectors ([1]). Furthermore, we study the accuracy in total variation of the approximation of the maximum distribution of bivariate geometric vectors by a Poisson distribution using the Stein-Chen method. Appropriate choices of normalizing constants for the componentwise maxima transform this Poisson distribution into a bivariate discretized Gumbel distribution. It turns out that the bounds on the approximation error are smaller than those obtained if we were to use the normalizing constants chosen by Mitov and Nadarajah in [2]. Also, we show that approximation by a discrete Gumbel distribution yields more accurate results than approximation by a continuous one. However, asymptotic results so far (e.g. [2], [3]) have mostly been concerned with the latter.

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Limiting Distributions of Maxima in Triangular Schemes

Frick, Melanie (speaker) University of Siegen, Germany, m.frick@mathematik.uni-siegen.de

Rolf–Dieter Reiss University of Siegen, Germany

Extreme value distribution; spectral density; triangular schemes; residual dependence:

It is well known that componentwise taken sample maxima of random vectors are asymptotically independent under a weak condition. Yet in important cases this tail independence is attained at a very slow rate and therefore the residual dependence structure plays a significant role.

We deduce limiting distributions of maxima in triangular schemes of random vectors. Such a result has been investigated by Hüsler and Reiss and by Hashorva in the special cases of normal and elliptically distributed random vectors, respectively. Our aim is to treat the problem on an abstract level. For that purpose we study technical conditions imposed on the densities of spectral distribution functions as utilized in two recent articles by Frick, Kaufmann and Reiss and Frick and Reiss.

References

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3:00-4:00 Session 4A continued

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LIMIT DISTRIBUTIONS IN CERTAIN LIMIT THEOREMS FOR EXTREME VALUES AND RATES OF CONVERGENCE

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VUKMIROVIĆ, JOVAN *University of Belgrade, Serbia*

Waiting times, urn models, extreme values, order statistics, rates of convergence:

(1) We sample with replacement from the set $N_n = \{1, 2, \ldots, n\}$, under the assumption that each element of N_n has probability $1/n$ of being drawn. A stoping rule is defined a priori. Possible limit distributions for the waiting time until a given portion of pairs jj, $j \in N_n$, is sampled will be presented. Some related results will also be given.

(2) Let $X^*_{n1}, \ldots, X^*_{nn}$ be independent random variables with the common negative binomial distribution with parameters $r > 0$ and $1/n$, where r is not necessarily an integer. We determine the limiting distribution of the random variable $M^*_n = \max\{X^*_{n1}, \ldots, X^*_{nn}\}$ as $n \to \infty$, corresponding normalizing constants and the rates of convergence. For an integer r the connection with certain waiting time problems is indicated.

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Tuesday, June 23

3:00-4:00 Session 4A

EXTREMES OF STUDENT'S T-STATISTICS FOR NON-NORMAL AND NOT NECESSARILY I.I.D. RANDOM VARIABLES

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Student's t-statistic, Self Normalized Sums, Asymptotic Behavior, Extreme Values, Non-Normal, Skewed, Heavy Tailed, Dependent, Non-Stationary, Non-I.I.D., Small Sample Size, False Positive/Discovery Rate, Test Power, High-Throughput Screening:

Let $X = (X_1, X_2, .., X_n)$, $n \geq 2$, be a random vector with continuous joint density g. Consider Student's t-statistic $T_n = \sqrt{n}\frac{\overline{X}-\mu_0}{\sqrt{S^2}}$, where $\overline{X}$ and S^2 stand for the sample mean and the sample variance respectively. We determine asymptotic expressions for $\mathbf{P}(T_n > u)$ when $u \to \infty$ and show they are accurate for small n. This gives a basis for new methods to correct theoretical p-values in high-throughput screenings, where sample size can be as low as two to five. The results are complemented by the examples and a simulation study.

References

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Tuesday, June 23

3:00-4:00 Session 4B

HEAVY TAILED FUNCTIONAL DATA ANALYSIS

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Time series; functional data; Banach space; extreme value; regular variation; linear process; functional maxima; spectral process:

A powerful way to model spatio-temporal phenomena is by means of time series of functional observations. For risk management purposes, the interest is often in the extremes of such processes; examples from the literature include sea levels along dikes in the Netherlands [5], windspeeds along the faces of a building [4], and precipitation in the state of Colorado [3]. In such cases, second moments cannot be assumed to exist, violating the basic assumption in standard functional data analysis based on the sequence of autocovariance operators [2, 8].

While originally defined for univariate functions and random variables, the concept of regular variation has by now been defined and studied in quite abstract settings, including the one of stochastic processes [7, 8]. As for random variables, regular variation provides the mathematical backbone for a coherent theory of extreme values. By considering our functional observations as points in a suitable function space, we are led to consider regularly varying time series taking values in Banach spaces.

As in the finite-dimensional case [1], joint regular variation of a stationary time series $(X_t)_{t\in\mathbb{Z}}$ in a separable Banach space $\mathbb{B}$ is shown to be equivalent to the existence of the limit in distribution of the rescaled process

$$(X_t/x)_{t\in\mathbb{Z}} \text{ conditionally on } \|X_0\| > x \text{ as } x \to \infty$$

in the proper product space. The limit in distribution is the *tail process*. It admits a familiar-looking decomposition into independent radial and angular components. The radial component is fully determined by the index of regular variation of $\|X_0\|$, while the angular component, called *spectral process*, effectively captures all aspects of extremal dependence: extremal indices, point processes of extremes, etc.

The theory is worked out for two classes of processes: moving maxima of continuous, real-valued functions on a compact domain and linear time series in an arbitrary separable Banach space. The second class of processes takes the general form

$$X_t = \sum_{i\geqslant 0} T_i(Z_{t-i}), \qquad t \in \mathbb{Z}.$$

The T_i are bounded linear maps between two separable Banach spaces $\mathbb{B}_1$ and $\mathbb{B}_2$ whereas the innovations $(Z_t)_{t\in\mathbb{Z}}$ are independent and identically distributed random elements in $\mathbb{B}_1$ whose common law is regularly varying. When $\mathbb{B}_1 = \mathbb{B}_2$, an interesting special case is the first-order autoregressive process $X_t = T(X_{t-1}) + Z_t$.

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3:00-4:00 Session 4B

Spatially aggregated flood risk estimates.

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Tawn, Jonathan A. Lancaster University, UK

Dunning, Paul JBA Consulting, UK

Spatial risk analysis; Spatio-temporal extremes; Simulation of rare events:

Modelling flood events over spatially extensive regions is of great importance to government agencies and the reinsurance industry. However, historically the methods used for flood risk management have limited capability to deal with the spatial dependence structure of extreme river flows and sea levels. Instead they focussed on single points rather than a wider area. In other words it has not been possible to answer questions such as ‘What is the distribution of the annual economic loss for a region?’, ‘What is the chance that many different locations will be affected by severe flooding?’ or ‘What is the chance that widespread river flooding will coincide with high tides and storm surge?’. In this talk we present a method that is capable of answering questions such as these.

Our method is based on the conditional dependence model of Heffernan and Tawn (2004). This model can handle large numbers of variables and both asymptotic dependence and asymptotic independence, it has also been extended by Keef et al (2009) to handle missing data and temporal dependence. We will show how it is possible to link this statistical model with a spatial interpolation model which has been designed specifically for river networks, and a damage model for the likely economic damage at individual locations given a river flow or sea level return period. In our method these models are linked together using a simulation scheme to obtain simulated flood events that reflect the spatial and temporal dependence structure of real flood events.

We illustrate the method on a network of river flow and tide gauge sites in North East England. In this illustration we demonstrate how our method can be used to answer the questions posed above and assess how well it answers these questions.

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Tuesday, June 23

3:00-4:00 Session 4B

An urn-based spatio-temporal shock model

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Keywords: Extreme-type Shock models; Urn scheme; Interacting particle System; Markov field; Defaults and Rare Events.

Abstract

Shock models are a particular class of models in which a system is randomly subject to different shocks of random magnitude that inevitably make it fail.

In the literature (see [3] for example) there are essentially three distinct types of shock models: cumulative shock models, in which the failure of the system is due to a cumulative effect; extreme shock models, whose default is caused by one single extreme shock; and mixed models, that combine the other two types. Generalizations are obviously possible.

Recently an urn approach to generalized extreme shock models has been presented in [1]. The idea is to model shocks and their effects on the system through the reinforcement scheme of a triangular urn process.

In [2], on the contrary, the authors introduce an interacting urn chain to model joint defaults of failing systems.

Even if, in most cases, they are able to effectively study extremal events such as defaults, these models are not realistic for some other situations in which the spatial dimension is fundamental.

In this paper we propose a new spatio-temporal shock model, in which several systems interact on a lattice. As usual, every system is subject to random shocks of random magnitude but these shocks are no more independent. On the contrary, they depend on the behavior of the neighboring systems. For example, we assume that the probability of a given system to fail increases with the number of failed neighbors, following the principle of cascading failures.

In more detail, we propose a urn model for such interacting systems. Every system is represented by an urn that is sampled. Every urn contains balls of different colors and each color represents a state of the system (for example no default - default) as in [1]. After every sampling, the urns are Polya-reinforced [5], according to their reinforcement matrix. However, differently from [1] and [2], the reinforcement matrix of every urn is no more fixed and stable over time. Reinforcement is indeed a function of three different components: 1) time (the so-called temporal contagion), 2) the configuration of the lattice and, in particular, of the clique to which every system belongs (spatial contagion), and finally 3) a random element (the impact of fate).

We assume that the entire grid collapses when a certain amount of systems fails. In our very general model, systems may recover from shocks or not.

The paper can be divided into three parts. In the first, we present the general construction of the spatio-temporal shock model and give very general results about its properties (martingale property, existence of a limit distribution). We also show that the whole lattice of interacting systems forms a Markov field, and we exploit this characteristic to build parallelisms with interacting particle systems [4], very popular in the physical literature.

3:00-4:00 Session 4B continued

In the second part of the paper we make some more assumptions about the urns involved in the model and their reinforcement matrices. This allows us to obtain more specific theoretical and computational results.

Finally, in the last part, we show some possible applications of our model to extreme events, such as the spread of cancer through cells, electrical blackouts and firms' defaults in industrial districts.

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Tuesday, June 23

3:00-4:00 Session 4B

Testing for spatial asymptotic independence using the madogram function

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Bivariate extremes; Asymptotic independence; Max-stable random fields; Spatial processes:

For spatial processes such as environmental ones, characterizing the main structure of the dependence of extreme spatial events is of fundamental interest, for instance in prediction purpose.

We first propose a new test for the asymptotic independence of bivariate maxima vectors.

It is based on the distribution of the madogram, the half absolute difference of the two random variables, a tool classically used in geostatistics to capture spatial structures.

The test resumes as a simple test on the mean and needs no tuning parameter.

We show that despite its simplicity, for bivariate vectors this test is as powerful as other tests in the literature [3],[4].

Then we extend it to spatial stationary fields focusing on pairwise asymptotic independence at lag h. A multiple test procedure is designed to determine at which lag asymptotic independence takes place.

When multiple realizations of the maxima fields are available this procedure is based on the bootstrap distribution of the number of times the null hypothesis is rejected.

When a single realization is available, the procedure works in a class of distances.

We tested it in both cases on maxima of three classical spatial models [5]: the storm model, the extremal Gaussian model and fields of Gaussian maxima.

An application of our test procedure is also given on two real climate datasets: maximum daily temperature values from 29 french towns over about 100 years, and maxima precipitations over 30 years in the french region Burgundy.

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Tuesday, June 23

4:30-6:00 Session 5

THE CONDITIONAL EXTREME VALUE MODEL AND DATA NETWORK SESSIONS

RESNICK, SIDNEY (speaker) Cornell University, Ithaca, NY USA, sir1@cornell.edu

data networks, sessions, Poisson, heavy tails, regular variation, multivariate extremes, conditioned limits:

The conditional extreme value (CEV) model is an alternative to multivariate extreme value modeling and is potentially applicable to modeling the distribution of a random vector if either some component of the vector is not in a unidimensional domain of attraction or else asymptotic independence requires supplementary lower order information. We survey properties and characterizations of this model, mention how it is related to standard and classical theory and outline detection techniques. We apply the methodology to data network sessions segmented by percentiles of a peak rate variable. (Joint work at various times with Jan Heffernan, Bikramjit Das, Luis Lopez-Oliveros.)

References

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THE TAIL EMPIRICAL PROCESS OF SOME LONG MEMORY PROCESSES

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RAFAŁ KULIK University of Ottawa, Canada

Keyword 1; Keyword 2; Keyword 3; Keyword 4:

The tail empirical process of a stationary sequence whose marginal distribution is in the domain of attraction of an extreme value distribution is a central object in the study of statistics based only on the largest observations, for instance the Hill estimator. Theoretical results are available for i.i.d. and weakly dependent data. We present results for long range dependent processes, including a stochastic volatility model wich may exhibit both long range dependence and heavy tails.

Tuesday, June 23 4:30-6:00 Session 5 continued

On the Estimation and Application of Max-Stable Processes

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Richard Smith University of North Carolina, USA

multivariate extremes; multivariate maxima of moving maxima; extreme value distribution; empirical distribution; estimation; extreme dependence; extreme co-movement.:

The theory of max-stable processes generalizes traditional univariate and multivariate extreme value theory by allowing for processes indexed by a time or space variable. We consider a particular class of max-stable processes, known as M4 processes, that are particularly well adapted to modeling the extreme behavior of multiple time series. We develop procedures for determining the order of an M4 process and for estimating the parameters. To illustrate the methods, some examples are given for modeling jumps in returns in multivariate financial time series. We introduce a new measure to quantify and predict the extreme co-movements in price returns.

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Wednesday, June 24

8:30-10:00 Session 6

Empirical processes at work: statistical analysis of extremal serial dependence

Drees, Holger (speaker) University of Hamburg, Germany, holger.drees@math.uni-hamburg.de

empirical processes, cluster functionals, extremal index, extremal dependence structure:

Recently Drees and Rootzén (2009) have introduced a very general class of empirical processes (indexed by functions) which describe certain aspects of the extreme value behavior of time series. Moreover they have proved the asymptotic normality of theses processes under suitable mixing conditions.

We discuss statistical applications of empirical processes of that type. E.g., Hsing (1991) proposed to estimate the extremal index of a time series by the ratio of the number of blocks of observations which contain at least one exceedance over a given high threshold and the total number of exceedances. Strengthening Hsing’s limit theorem, we easily gain deeper insight into the influence of the threshold on the asymptotic behavior of this estimator.

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Wednesday, June 24

8:30-10:00 Session 6

Extremes of Autoregressive Threshold Processes

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Fasen, Vicky *Munich Technical University, Germany*

exponential tail; O-regular variation; regular variation; SETAR process; subexponential distribution:

An autoregressive threshold (TAR) model of order q with S regimes is a piecewise AR(q) process, where the current regime depends on the size of the past observations. More precisely, by a TAR(S, q) process with noise $(Z_k)_{k\in\mathbb{N}_0}$ we mean a process $(X_k)_{k\in\mathbb{N}_0}$ which satisfies

$$X_k = \sum_{i=1}^{S}\{\alpha_i + \sum_{j=1}^{q}\beta_{ij}X_{k-j}\}\mathbf{1}_{\{(X_{k-d_1},\ldots,X_{k-d_p})\in J_i\}} + Z_k, \quad k \geq \max\{q, d_p\},$$

where $p, q, S, d_1, \ldots, d_p \in \mathbb{N}$ with $d_1 < \ldots < d_p$, α_i and β_{ij} are real coefficients and $\{J_i : i = 1, \ldots, S\}$ is a partition of $\mathbb{R}^p$ into Borel sets. These models have been introduced by Tong in 1977 and since then found various applications in many areas, such as financial economics, population dynamics or physics, to name just a few. In particular, when used as a model for financial data, it is important to have information about the tail- and extremal behaviour of these models, since a stylised fact of financial data is that they have heavy tails and cluster on high levels.

We shall investigate tail and extremal behavior for different classes of (semi-)heavy tailed i.i.d. noise sequences (Z_k): if Z_1 is in the maximum domain of attraction of the Gumbel distribution and has either an exponentially decreasing tail (i.e. is in $\mathcal{L}(\gamma)$ with $\gamma > 0$) or is subexponential, then the stationary solution of the TAR process is tail equivalent to the noise sequence, and the extremal index is equal to 1, so that extremes do not occur in clusters. If however Z_1 is in the maximum domain of attraction of the Frechét distribution, i.e. has regularly varying tail, then the stationary TAR model has in general only O-regularly varying tail. However, if the partition $\{J_i : i = 1, \ldots, S\}$ is a partition into disjoint intervals, then it is shown that the stationary version of TAR(S, 1) processes with regularly varying noise has also regularly varying tails. The finite dimensional distributions are then multivariate regularly varying, and the extremal behavior is studied via point processes. The extremal index is furthermore determined, which is shown to be strictly less than 1 for a large set of parameter values, and hence this model can exhibit cluster behaviour.

The talk is based on [1].

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Wednesday, June 24

8:30-10:00 Session 6 continued

BIAS IN RETURN LEVEL ESTIMATION INCURRED BY PEAKS-OVER-THRESHOLD ANALYSES

WALSHAW, DAVID (speaker) Newcastle University, United Kingdom,

FAWCETT, LEE Newcastle University, United Kingdom

Peaks-Over-Threshold; Generalized Pareto Distribution; Return levels; Estimation bias:

When making inferences about extremes of environmental variables from observed time series of data, it is common for practitioners to employ Peaks-Over-Threshold (POT) methods. In such cases an ad hoc method is usually employed to identify clusters of exceedances of a suitable high threshold, and the largest value from each cluster is selected to provide a set of approximately independent observations for analysis.

The purpose of this talk is to provoke a rethink on the usefulness of such procedures. We demonstrate that the very process of selecting a single representative observation from a cluster usually incurs a bias on return level estimation which persists over a wide-range of cluster identification techniques and different levels and types of dependence (Fawcett and Walshaw, 2007).

We propose that when interest is solely in return level estimation, it is almost always more sensible to avoid the identification of clusters altogether. Instead, we should model all exceedances of the chosen threshold, and make a straightforward adjustment to the estimation uncertainty based on an empirical measure of the effect of serial dependence. We demonstrate that such methods show much better performance than POT methods over a wide range of scenarios.

References

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10:30-12:00 Session 7

GOODNESS-OF-FIT TESTING FOR WEIBULL-TYPE BEHAVIOR

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YURI GOEGEBEUR University of Southern Denmark, Denmark

Extreme value statistics; Weibull-type model; Weibull-tail coefficient; Goodness-of-fit:

In the process of analyzing data, testing the fit of a model under consideration is a prerequisite for performing inference about the model parameters. In this paper we examine the goodness-of-fit testing problem for assessing whether a sample is consistent with the Weibull-type model. Inspired by the Jackson and the Lewis test statistics, originally proposed as goodness-of-fit tests for the exponential distribution, we introduce two new statistics for testing Weibull-type behavior, and study their asymptotic properties. Moreover, given that the statistics are ratios of estimators for the Weibull-tail coefficient, we obtain new estimators for the latter, and establish their consistency and asymptotic normality. The small sample behavior of our statistics and estimators is evaluated on the basis of a simulation study.

Wednesday, June 24

10:30-12:00 Session 7

On the structure of max–stable processes

Stoev, Stilian (speaker) University of Michigan, Ann Arbor, USA, sstoev@umich.edu

Wang, Yizao University of Michigan, Ann Arbor, USA, yizwang@umich.edu

max–stable processes; max–linear isometries; minimal spectral representations; non–singular flows; ergodic theory :

Max–stable processes arise in the limit of component–wise maxima of independent processes and thus they play a key role in modeling extreme value phenomena. In this talk, we present new classification results for max–stable processes. They are based on the notion of a minimal spectral representation, also known as proper in the context of the pistons of de Haan and Pickands. These results are analogous to existing classification results for sum–stable processes. In the max–stable setting, however, the novel concept of co–spectral functions yields a unifying perspective to a number of classifications. We will discuss three types of classifications: (i) spectrally continuous/discrete, (ii) conservative/dissipative, and (iii) positive/null. Their interplay will be demonstrated over practical examples such as the moving maxima and Brown–Resnick type processes.

Selected References

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10:30-12:00 Session 7

A QUASI-PORT METHODOLOGY FOR VaR: SECOND-ORDER REDUCED-BIAS ESTIMATION

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Statistics of extremes; Value at Risk; Semi-parametric estimation; Bootstrap methodology:

Under a semi-parametric framework, we shall deal with the estimation of a positive *extreme value index* γ, the primary parameter in *Statistics of Extremes*, and associated estimation of the *Value at Risk* at a level p, denoted VaR_p, the size of the loss occurred with a fixed small probability p. We shall consider parents with a right tail function $\overline{F}(x) := 1 - F(x) = (x/C)^{-1/\gamma}\left(1 + D(x/C)^{\rho/\gamma} + o\left(x^{\rho/\gamma}\right)\right)$, as $x \to \infty$, with $\rho < 0$. For these heavy-tailed parents and given a sample $\mathbf{X}_n = (X_1, \cdots, X_n)$, the classical extreme value index estimator is the Hill estimator (Hill, 1975), here denoted $H = H_n(k)$, the average of the k log-excesses over a high random threshold $X_{n-k:n}$, an *intermediate* order statistic with rank $n - k$ (with $k = k_n \to \infty$ and $k/n \to 0$, as $n \to \infty$). But the Hill estimator (as well as the associated VaR-estimator) reveals usually a high asymptotic bias, i.e., $\sqrt{k}\,(H_n(k) - \gamma)$ is asymptotically normal with variance γ^2 and a non-null mean value whenever $\sqrt{k}(n/k)^\rho \to \lambda \neq 0$ and finite. This non-null asymptotic bias, together with a rate of convergence of the order of $1/\sqrt{k}$, leads to sample paths with a high variance for small k, a high bias for large k, and a very sharp mean squared error pattern, as function of k. Recently, several authors have been dealing with bias reduction in the field of *extremes* and a simple class of second-order minimum-variance reduced-bias (MVRB) extreme value index estimators is the one in Caeiro *et al.* (2005), used for a semi-parametric estimation of $\ln VaR_p$ in Gomes and Pestana (2007). This class, here denoted $\overline{H} = \overline{H}_n(k)$, depends upon the estimation of second order parameters, and if these second order parameters are suitably estimated, $\sqrt{k}\left(\overline{H}_n(k) - \gamma\right)$ is asymptotically normal with variance γ^2, a null mean value whenever $\sqrt{k}(n/k)^\rho \to \lambda$ finite and an optimal k-value such that $\sqrt{k}\;A(n/k) \to \infty$. This enables these estimators to outperform the Hill estimator H for all k. Moreover, they are approximately location invariant. With Q standing for quantile function, the classical Var_p-estimator, $Q_{p|H}(k) = Q_{p|H}(k; \mathbf{X}_n) := X_{n-k+1:n}\,(k/(np))^{H_n(k)}$, has been introduced in Weissman (1978). For any real positive δ, $Q_{p|H}(k; \delta\mathbf{X}_n) = \delta\; Q_{p|H}(k; \mathbf{X}_n)$, as desirable, but contrarily to the linear property for quantiles, $\chi_p(\delta X + \lambda) = \delta\chi_p(X) + \lambda$ for any real λ and real positive δ, we no longer have $Q_{p|H}(k; \lambda\mathbf{1} + \delta\mathbf{X}_n) = \lambda + \delta\; Q_{p|H}(k; \mathbf{X}_n)$. Araújo Santos *et al.* (2006) developed a class of high quantile estimators based on a sample of excesses over a random threshold $X_{n_q:n}$, i.e., based on $\mathbf{X}_n^{(q)} := \left(X_{n:n} - X_{n_q:n}, X_{n-1:n} - X_{n_q:n}, \cdots, X_{n_q+1:n} - X_{n_q:n}\right)$, where $n_q := [nq] + 1$, being $0 < q < 1$, for distributions with finite or infinite left endpoint $x_F := \inf\{x : F(x) > 0\}$ (*the random threshold is an empirical quantile*) and $q = 0$, for distributions with a finite left endpoint x_F (*the random threshold is the minimum*). They proposed the so-called $PORT$-Weissman-Hill VaR_p-estimators, $Q^{(q)}_{p|H} = (X_{n-k_n:n} - X_{n_q:n})\,(k/(np)))^{H_n^{(q)}(k)} + X_{n_q:n}$, where $H_n^{(q)}(k)$ is based upon the Hill estimator of γ, made location/scale invariant by using the transformed sample $\mathbf{X}_n^{(q)}$. They then obtain exactly the above mentioned linear property for the quantile estimators. We shall here consider the quasi-PORT reduced-bias Var_p-estimators $Q^{(q)}_{p|\overline{H}}$, based upon the MVRB estimators $\overline{H}$. The above mentioned linear property is thus obtained only approximately. The new class of estimators will be compared with previous ones, both asymptotically and for finite samples, through Monte Carlo techniques. Despite of the usual stability on k of the MVRB estimates $\overline{H}$ and the new VaR-estimates, we also propose the use of bootstrap computer-intensive methods for the choice of k. Applications in the fields of insurance and finance will be provided.

References

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Thursday, June 25

8:30-10:00 Session 8

Second order approximation of the tail of the distribution of the maximum of a Gaussian process

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Distribution of the maximum; Gaussian field:

Let $\mathcal{X} = \{X(t) : t \in S\}$ be a real-valued Gaussian random field defined on some compact parameter set $S \subset R^d$ and $M := \sup_{t \in S} X(t)$ its supremum. We assume that the paths of $\mathcal{X}$ as well as the geometry of S have some regularity. We will present some recent results which allow, in certain cases, to give more precise approximations of the tails of the distribution of the random variable M. We will be especially interested in the approximation of $P(M > u)$ for large u, but we also give results that are valid for all u.
Whenever it is possible, we want to write:

$$P\{M > u\} = A(u) \exp\left(-\frac{1}{2}\frac{u^2}{\sigma^2}\right) + B(u) \tag{1}$$

where $A(u)$ is a known function having polynomially bounded growth as $u \to +\infty$,
$\sigma^2 = \sup_{t \in S} Var(X(t))$ and $B(u)$ is an error bounded by a centered Gaussian density with variance σ_1^2, $\sigma_1^2 < \sigma^2$. We call the first (respectively the second) term in the right-hand side of (1) the "first (resp second) order approximation of $P\{M > u\}$."

References

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Thursday, June 25

8:30-10:00 Session 8 continued

CONFIDENCE BOUNDS FOR CURVE PREDICTION USING THE DISTRIBUTION OF THE MAXIMUM OF GAUSSIAN PROCESSES

JEAN-MARC, AZAÄIS *University of Toulouse, France*, azais@cict.fr

Gaussian processes; Fourier basis; Thresholding; Simultaneous statistics:

We present numerical methods including MCQMC method of Genz [4] [2] and Sidak's inequality to compute the distribution of the maximum of a Gaussian time series of size *n*. For large *n* this approach is better than the use of extreme approximation.

The method is extended to Gaussian process by a generalization of the Rice method [3] [5].

Finally we present [1] an application to the construction of simultaneous con¯dence bands in the prediction of load curves for EDF, the electrical French group. The method is based on compression-denoising on the Fourrier basis and then a regression of the Fourrier coe±cient on some explanatory variables. Under certain conditions the error process is approximatively Gaussian and the methods above can be applied.

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8:30-10:00 Session 8 continued

Recent results on extremes of Gaussian processes

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Keywords: *Gaussian processes; supremum; asymptotic behavior; local stationary processes*

Abstract

We review some recent results on the behavior of extremes of Gaussian processes. The Gaussian processes $X(t)$ are restricted by assumptions on the mean and the covariance functions. The time may be discrete or continuous. It is well-known that under certain conditions the discrete time process approximates well the related continuous one.

We focus mostly on the asymptotic behavior of the exceedance probability of the supremum of a continuous Gaussian process as the parameter u, a fixed boundary parameter is tending to ∞, i.e. $P(\max_{t\in[0,T]} X(t) > u)$ for T fixed or depending on u. The cluster behavior of exceedances is of particular interest. We investigate also double clusters of exceedances which are separated by a time lag.

In some results the mean of the process is not a deterministic function, but is given by an independent random process. This allows to investigate random environment or random boundary type problems. The composite process is then not a Gaussian process, but assumed to be a product of a Gaussian and a non-Gaussian one. Other results discuss the increments of smooth and non-smooth Gaussian processes which are useful statistics for instance for storage processes.

In many cases only the points of maximal variance or largest correlation have an impact on the asymptotic behaviour. It implies that the assumptions on the Gaussian process can be relaxed such that some of results hold quite general.

10:30-12:00 Session 9A

LARGE DEVIATION PRINCIPLE FOR A CLASS OF LONG RANGE DEPENDENT INFINITELY DIVISIBLE PROCESS

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Large Deviations; Long Range Dependence; Infinitely Divisible; Markov Chains:

We make an attempt at understanding the effect of long range dependence on the large deviation principle for the partial sums of an infinitely divisible process. It has been observed in certain short memory processes that the large deviation principle is very similar to that of an i.i.d sequence. Whereas, if the process is long range dependent the large deviations change dramatically. We want to see if such a phenomenon holds for infinitely divisible processes.

We consider a stationary, mean zero infinitely divisible process $(X_n, n \in \mathbb{Z})$ without a Gaussian component but with exponentially light tails. The process is characterized by its Lévy measure Π on $\mathbb{R}^{\mathbb{Z}}$ which is shift invariant. With the aim of modeling long range dependence for such processes, we consider the situation where the Lévy measure is the law of the paths of an irreducible null recurrent Markov Chain with the marginals being the invariant measure π of the chain, i.e., for any $n \geq 1$ and $A_0, \ldots, A_n \in \mathcal{B}(\mathbb{R})$,

$$\Pi\big(z \in \mathbb{R}^{\mathbb{Z}} : (z_0, \ldots, z_n) \in A_0 \times \cdots \times A_n\big) = \int_{A_0} \cdots \int_{A_n} \pi(dz_0) P(z_0, dz_1) \cdots P(z_{n-1}, dz_{n-1}),$$

where $P(\cdot, \cdot)$ is the transition kernel of the Markov chain. We study how the structure of this Markov chain affects the large deviation principle for the partial sums of the process (X_n).

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Thursday, June 25

10:30-12:00 Session 9A

LARGE DEVIATIONS FOR RANDOM WALKS UNDER SUBEXPONENTIALITY: THE BIG-JUMP DOMAIN

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Large deviations; random walk; subexponentiality:

Stimulated by applications to internet traffic modeling and insurance mathematics, distributions with heavy tails have been widely studied over the past decades. This talk addresses a fundamental large-deviation problem for random walks with subexponential step-size distributions.

These random walks exceed a large level x at some fixed time n as if exactly one of the n steps exceeds x while the others behave according to their mean. We investigate in which cases this remains true as n and x both grow large, thus identifying the so-called the big-jump domain.

References

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Geometric characteristics of the excursion sets over highl levels of non-Gaussian infinitely divisible random fields

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Rober Adler *Technion, Israel*
Jonathan Taylor *Stanford University, USA*

high level excursion set; geometric characteristics ; infinitely divisible; random field:

We consider smooth infinitely disivible random fields of the type $\left(X(t),\, t \in [-1,1]^d\right)$, with regularily varying Lévy measure. For such random fields we are interested in the geometric characteristics of the excursion sets

$$A_u = \left\{ t \in [-1,1]^d : X(t) > u \right\}$$

over high level u.

For a large class of random fields we compute the asymtotic (as $u \to \infty$), conditional on A_u being non-empty) joint distribution of the of the numbers of critical points over the level u of all types. This allows us, for example, to obtain the asymptotic conditional distribution of the Euler characteristic of the excursion set.

In a significant departure from the Gaussian situation, the excursion set over a high level for smooth random fields we are considering, can have complicated geometry. In the Gaussian case the excursion set, unless it is empty, is nearly certain to be “a ball-like” and have its Euler characteristic equal to one. In contrast, the Euler characteristic of the excursion sets in our model can have a highly non-degenerate conditional distribution.

10:30-12:00 Session 9B

Asymptotic independence of the components for random vectors from unimodal densities

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Asymptotic independence; extremal dependence; limit set; light-tailed densities:

The concept of asymptotic independence of the components of random vectors has been useful in diverse areas of application. The importance of understanding extremal dependence properties of underlying models cannot be overestimated in any risk analysis.

The standard criteria for checking asymptotic independence are given in terms of distribution functions (dfs), which are rarely available in an explicit form, especially in the multivariate case. Usually, we are given an analytic form of the density or, via the shape of data clouds, one can infer a good geometric image of the asymptotic shape of the density level sets. Our aim is to provide simple sufficient conditions on the joint density of a random vector which guarantee asymptotic independence for its components. We focus primarily on the light-tailed densities, with a parallel comparison to the heavy-tailed case. This allows to gain further insights in differences between dependence and asymptotic dependence.

A brief overview of existing criteria for asymptotic independence as well as several useful extensions will be presented. To clarify ideas we first introduce a simple class of homothetic densities completely specified by a bounded open star-shaped set containing the origin which determines the shape of the density level sets and a continuous, strictly decreasing function which governs the decay of the tails. This class is then generalized to include densities whose level sets are only asymptotic to such a bounded open star-shaped set in the sense that they can be scaled to converge to this set. The criteria for asymptotic independence of random vectors from a density in one of these two classes are formulated in terms of the requirements on the asymptotic shape of the density level sets. Several examples will be given for illustration.

AGGREGATION OF RAPIDLY VARYING RISKS AND ASYMPTOTIC INDEPENDENCE.

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Risk; Gumbel; Maximal domain of attraction; Asymptotic independence; Subexponential :

Abstract

We study the tail behavior of the distribution of the sum of asymptotically independent risks whose marginal distributions belong to the maximal domain of attraction of the Gumbel distribution. We impose conditions on the distribution of the risks (X, Y) such that $P(X + Y > \chi) \sim (\text{const})P(X > \chi)$. With the further assumption of non-negativity of the risks, the result is extended to more than two risks. We note a sufficient condition for a distribution to belong to both the maximal domain of attraction of the Gumbel distribution and the subexponential class. We provide examples of distributions which satisfy our assumptions. The examples include cases where the marginal distributions of X and Y are subexponential and also cases where they are not. In addition, the asymptotic behavior of linear combinations of such risks with positive coefficients is explored leading to an approximate solution of an optimization problem which is applied to portfolio design.

Thursday, June 25

10:30-12:00 Session 9B

MODELLING MULTIVARIATE JOINT TAILS AND A NEW CLASS OF BIVARIATE SURVIVAL FUNCTIONS

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SMITH RICHARD L. University of North Carolina at Chapel Hill, USA

REN RUOEN Beihang University, China

Joint tail; Multivariate extreme value theory; Asymptotic independence; Asymptotic dependence; Regular variation:

Ledford and Tawn (1996,1997) extended the traditional approach based on bivariate extreme value theory to model the joint extreme events, by incorporating positively and negatively associated asymptotic independence into asymptotic dependence and exact independence. However, their model is only limited to the bivariate case and is provided with very sparse parametric models - only one continuous model recently by Ramos and Ledford (2009). This paper generalizes their models into multivariate context under certain assumptions, and proposes a general technique to construct multivariate parametric models consistent with their framework, by deriving angular measures satisfying the model constraint. A rich and flexible parametric family is derived suitable to model the dependence within the bivariate joint tail region. Statistical inference and simulations are given for this new class.

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Thursday, June 25

10:30-12:00 Session 9B

TAIL PROPERTIES OF MULTIVARIATE ARCHIMEDEAN COPULAS

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Multivariate Archimedean copula; coefficient of tail dependence; regular variation; tail dependence copula:

The extremal behavior of Archimedean copulas has been studied by several authors, among others Charpentier and Segers ([1] and, in particular, [2]) and Juri and W¨uthrich [3]. Based on recent work by McNeil and Neˇslehov´a [4], we describe how multivariate Archimedean copulas arise naturally as the dependence structures of mixtures of radially scaled copies of the unit simplex. This yields a simple stochastic representation of such copulas, which we exploit to derive several results about the tail properties of general d-dimensional Archimedean copulas in a transparent fashion. Specifically, we consider the limiting copulas of multivariate (componentwise) maxima and threshold exceedances for the case where the copula or survival copula of the underlying distribution is Archimedean. We also obtain an explicit example of an Archimedean copula where the coefficient of tail dependence does not exist.

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Thursday, June 25

10:30-12:00 Session 9B continued

Multivariate Tail Dependence Measures for Archimedean Copulas

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Tail dependence coefficient; Archimedean copulas; regular variation:

Dependencies of extreme events of bivariate distributions can be measured by the tail dependence coefficient which describes the amount of dependence in the upper right tail or lower left tail of the distribution. We investigate different multivariate generalizations (see [1-6]) and apply them to the family of Archimedean copulas. In recent work this family has gained increasing interest because of its analytical tractability and its great flexibility in modeling. Archimedean copulas are characterized by a univariate function, the so called Archimedean generator. It will be shown that the index of regular variation of the Archimedean generator is essential in all possible generalizations. The results help to indicate which Archimedean generator fits best to the data or to the desired model.

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10:30-12:00 Session 9B continued

Conditional extreme value models: Characterization and detection techniques

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Regular variation; Domain of attraction; Asymptotic independence; Conditioned limit theory :

Extreme value theory is often used to model environmental, financial and internet traffic data. Multivariate EVT assumes a multivariate domain of attraction condition for the distribution of a random vector necessitating that each component satisfy a marginal domain of attraction condition. Heffernan & Tawn (2004) and Heffernan & Resnick (2007) developed an approximation to the joint distribution of the random vector by conditioning on one of the components being in an extreme-value domain. The usual method of analysis using multivariate extreme value theory often is not helpful either because of asymptotic independence or due to one component of the observation vector not being in a domain of attraction which we can overcome by using the conditional model. The prior papers left unresolved the consistency of different models obtained by conditioning on different components being extreme and we provide understanding of this issue. We also clarify the relationship between the conditional distributions and multivariate extreme value theory and extensions from one to the other. An important characterization of this model is in terms of the limit measure forming a product or not which leads to a dichotomy in estimation of the model parameters. We propose three statistics which act as tools to detect the plausibility of using this model as well as whether it is a product or not. The methods are applied on an internet traffic data set. We also indicate results for a multivariate extension for the model (dimension greater that 2).

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Thursday, June 25

1:30-2:30 Session 10A

STATISTICAL MODELING OF HOT SPELLS AND HEAT WAVES

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Climate change; Clustering of extremes; Conditional generalized Pareto distribution; Point process approach :

Heat waves are an extreme meteorological event with substantial societal impact. Consequently, there is much concern about possible changes in their frequency, duration, and intensity as part of global climate change. Yet the statistical theory of extreme values has only rarely been applied to such events, especially not in the context of climate change.

The point process approach is readily applicable to extreme high temperature events which have been de-clustered to eliminate temporal dependence (i.e., modeling only cluster maxima). In such a framework, the incorporation of trends is straightforward. We extend this approach to hot spells (i.e., clusters of high temperatures) through explicit modeling of the temporal dependence of excesses within a cluster. To simplify matters, we fit the point process model to the first excesses of the clusters, not the cluster maxima. A geometric distribution is assumed for the cluster length. Conditional on this length, the individual excesses are modeled as conditional generalized Pareto (GP) distributions, with the scale parameter depending on the previous excess. This model has the advantage of only requiring univariate extreme value theory, being implemented using existing software for fitting the GP distribution with covariates. One alternative, with a firmer theoretical basis but more complex to apply, would be to make use of bivariate extreme value theory and model the temporal dependence of excesses within a cluster as a Markov process.

The proposed statistical model for hot spells is fitted to summer time series of daily maximum temperature at three locations, Phoenix, AZ, Fort Collins, CO, and Paris, France. Possible trends in each component (i.e., frequency, duration, and intensity) of the statistical model for hot spells are considered. To convert the model for hot spells into the corresponding statistical properties of more realistic heat waves (e.g., combining clusters that are close together, using a higher threshold), a heat wave simulator is developed.

Thursday, June 25

1:30-2:30 Session 10A

Extreme behavior of large scale indicators for severe weather

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Severe Weather; Climate; wind max; shear:

A major concern related to climate change pertains to the behavior of severe weather that can be accompanied by a high cost in terms of life and economic damage. Many of the kinds of severe weather associated with such loss, such as tornadic storms, occur on too fine a scale for climate models to resolve them. One technique to ascertain something about such phenomena under a changing climate is to look at large-scale indicators for severe weather. Here, we analyze the extreme behavior of one large-scale indicator, the product of wind max and 0-6 km wind shear, using statistical extreme value analysis (EVA). The study is primarily conducted on a global reanalysis data set covering 42 years up to 1999. Both the frequency and intensity of extremes of this indicator are studied.

This work is supported by theWeather and Climate Impacts Assessment Science Project (http://www.assessment.ucar.edu), which is funded by the National Science Foundation (NSF).

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Regional Climate, NARCCAP, and Heat Waves

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The North American Regional Climate Change Assessment Program (NARCCAP) is an ambitious multi-agency, multi-institution collaboration producing regional projections of climate change for North America based on a multi-model ensemble of regional climate models. In this talk, I will describe the NARCCAP experiment and discuss statistical methodology for synthesizing the complex output from the ensemble. In particular, I will present an assessment of the changing number and duration of heat waves. The analysis of heat waves and other measures of heat stress represents, perhaps, a departure from typical approaches for considering extremes, but it is nonetheless an area of interest to those studying the impacts of climate change in such areas as public health, agriculture, power management, etc.

Thursday, June 25

1:30-2:30 Session 10B

Infinite variance stable limits for sums of dependent random variables

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stationary sequence, stable limit distribution, weak convergence, mixing, weak dependence, characteristic function, regular variation, GARCH, stochastic volatility model, ARMA process.:

This talk provides conditions which ensure that the affinely transformed partial sums of a strictly stationary process converge in distribution to an infinite variance stable law. Conditions for this convergence to hold are known in the literature, see Davis and Hsing (1995) and Jakubowski (1997). However, most of these results are qualitative in the sense that the parameters of the limit distribution are expressed in terms of some limiting point process. In this talk we determine the parameters of the limiting stable distribution in terms of some characteristics of the underlying stationary sequence. We apply these results to some standard time series models, including the GARCH(1,1) process and its squares, the stochastic volatility models, solutions to stochastic recurrent equations and symmetric □-stable processes.

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Modeling rare events through a pRARMAX process

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LUISA CANTO E CASTRO University of Lisbon, Portugal

Extreme value theory; Max-autoregressive models; Classification theory; Bayes error:

In Ferreira and Canto e Castro (2008), a power max-autoregressive process (in short pARMAX) is presented as an alternative to heavy tailed ARMA when modeling rare events. Now we consider an extension of pARMAX by including a random component which makes the model more applicable to real data. We will see conditions under which this new model, here denoted as pRARMAX, has unique stationary distribution and we analyze its extremal behavior. Based on Bortot and Tawn (1998), we derive a threshold-dependent extremal index as a functional of the coefficient of tail dependence of Ledford & Tawn (1996, 1997) which in turn relates with the pRARMAX parameter. In order to fit a pRARMAX model to an observed data series, we present a methodology based on minimizing the Bayes risk in classification theory and analyze this procedure through a simulation study. We illustrate with an application to financial data.

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1:30-2:30 Session 10B

ON PRECISE ESTIMATES FOR A CLASS OF RANDOM RECURRENCE EQUATIONS

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Large deviations, implicit renewal theory, ruin with investments, GARCH financial time series models.

In this talk we will be concerned with random recurrence equations, namely, equations of the form

$$Y \stackrel{d}{=} \Phi(Y), \tag{1}$$

where Φ is a random function and Y is a random variable on $\mathbf{R}$. Such equations arise in a wide variety of problems in insurance, finance, and applied probability. For example, if $\{Y_n\}$ denotes a risk process, associated with an insurance company with i.i.d. stochastic returns on its investments, then it can be shown that (1) takes the form

$$Y = B + A\max\{0, Y\}, \quad \text{where} \quad Y := \sup_n Y_n, \tag{2}$$

for certain random variables A and B where $\mathbf{E}[A] < 1$, and $\mathbf{P}\{\text{ruin}\} = \mathbf{P}\{Y > u\}$. Similarly, if $\{Y_n\}$ denotes the squared volatility of an investment governed by the standard GARCH(1,1) time series model, then

$$Y = B + AY, \quad \text{where} \quad Y := \lim_{n\to\infty} Y_n. \tag{3}$$

The tail behavior of a random variable Y satisfying Eq. (1) has been studied in a well known paper of Goldie [2], who established an asymptotic result which—when specialized to the setting of Eqs. (2) or (3) above—takes the form

$$\mathbf{P}\{Y > u\} \sim Cu^{-R} \quad \text{as} \quad u \to \infty. \tag{4}$$

An extension to quite general Markovian processes has recently been given in Collamore [1]. In such estimates, the constant R is generally known explicitly, although not the constant C.

The purpose of this talk will be to discuss some related results which go beyond the estimates of [1] and [2]. In particular, we will be concerned with such questions as the duality (which arises, say, between the processes described in (2) and (3)), and some explicit computational and analytical methods relevant, e.g., for obtaining precise bounds for the quantity on the left-hand side of (4). (Some of this talk will be based on joint research with Harri Nyrhinen, Univ. Helsinki.)

References

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1:30-2:30 Session 10B continued

On Some Extremal Characteristics of GARCH Processes

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GARCH; tail chain; extremal index; extremal coefficient function; regular varation; estimation by simulation:

Two stylized facts of financial returns, namely volatility clustering and heavy tails, can simultaneously be reflected by the class of GARCH processes. The analysis of extremal clusters of these processes calls for simple measures that basically indicate the main characteristics of such events. Here, the extremal index that essentially corresponds to the average cluster size, and the extremal coefficient function, an analogue of the autocovariance for extremes, have been proposed. For both characteristics no analytical expression in terms of the GARCH parameters exists. A practicable evaluation of both measures has been studied in Mikosch and Stărică (2000) and Fasen et al. (2009), respectively.

We will tackle the issue of evaluation from two sides: First, we make use of the fact that the extremes of a Markov chain may be modelled by a certain (back and forth) tail chain, cf. Segers (2007). Its behavior virtually corresponds to a random walk given an extreme observation of the original process. The tail chain approach has been implemented in de Haan et al. (1989) with respect to the extremal index of ARCH processes. We extend this theory in order to handle the extremal behavior of two connected time series, e.g. $(X_i, i \in \mathbb{Z})$ and $(\sigma_i^2, i \in \mathbb{Z})$, where (σ_i^2) is a Markov process with a certain asymptotic behavior and X_i is of the form $X_i = \phi(\sigma_i, \epsilon_i)$. In the special case of a GARCH(1,1) process an extension of a theorem in Segers (2007) allows us to identify the limiting distribution $\lim_{x\to\infty} \mathcal{L}(X_0/x, \epsilon_0^2 | X_0 > x)$ which can be used as a starting point for a tail chain simulation of the extremal index. This yields a simplification of previous considerations of this kind.

Furthermore, we shall discuss why reflection invariance may be regarded as a shortcoming of the extremal coefficient function. This, of course, depends on the intended interpretation but appears to be especially evident when analyzing the course of financial extreme events. We propose an alternative characteristic which when evaluated for GARCH(1,1) processes turns out to be an application for the theory of backward tail chains. See the poster "A New Perspective on Extremal Dependence: The Example of GARCH Processes" by Andree Ehlert for details of this new characteristic.

Second, we extend the simulation of the extremal index to some GARCH processes of higher order than (1,1) by combining simulation approaches from Basrak and Segers (2009) and Laurini and Tawn (2006). Here, the knowledge of κ, the tail index of regular variation for both (X_i^2) and (σ_i^2), is a crucial point since it is a required parameter for our simulations. However, for GARCH(p,q) processes of higher order than (1,1) this index cannot be found analytically. We make use of a stationarity property of the spectral measure of the process (σ_i^2) to find an estimate of κ for a given GARCH(p,q) process.

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Thursday, June 25

2:30-3:45 Session 11A

Max-stable model for climate extremes. Application to extreme snow depth in the Swiss Alps.

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Extreme events; Max-stable process; Snow depth; Switzerland:

In recent years, there has been a growing interest in spatial extremes within the climate community. For many practical applications, an important issue is
to model extreme events anywhere in space, and not only at some specific locations.
For example, determining the probability of snow depth exceeding some level anywhere on a mountain slope is needed for avalanche risk calculation.
To tackle such issues, the process under study has therefore to be modeled as a spatially continuous process.
The most natural way for the continuous space specification of extremes is provided by the theory of max-stable processes which can be seen as an extreme value analogy of Gaussian processes.
Two different characterizations have been proposed in [Smith, 1991] and [Schlather, 2002].
In this article, a modified version of Schlather's characterisation [Schlather, 2002] is adopted in order to account for the specificities of climatological extremes. First, climatological processes are usually governed by different weather systems, creating different climatological regions which are included in our model. Second, the Cartesian distance is usually not appropriated to determine how distant two locations are -and therefore how dependent they are-. Hence, a better "climatological space" is introduced in the model. Finally, climatological processes are not only spatially variable, but also locally variable. This local variability is usually very complex to understand because many external events (wind, exposition...) can play a role. But Schlather's model assumes a "smooth" process in space and neglecting such local variability strongly affects the correlation function involved in the model. To tackle this issue, we propose to introduce weights in the likelihood function: the more representative from the neighboring area a location is, the more it weights in the likelihood.
In the proposed model, all the specificities mentioned above are accounted for without any a priori knowledge being required. Estimation is performed by approximating the full likelihood -which is out of reach for max-stable processes- by the pairwise likelihood of [Cox and Reid, 2004]. A simulation study illustrates the perfomance of the model. An application to extreme snow depth in the Swiss Alps is also presented.

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2:30-3:45 Session 11A continued

Interest of rainfall probabilistic model based on atmospheric circulation patterns

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Multi-exponential weather pattern distribution ; Extreme rainfall ; Atmospheric circulation patterns ; Schadex :

EDF (Électricité de France) design floods of dam spillways are now computed using a probabilistic method named SCHADEX (Climatic-hydrological simulation of extreme floods)[1]. In this method extreme rainfall quantiles are estimated using a combination of exponential distributions applied on several sub-samples of rainfall observations, discriminated with eight atmospheric circulation patterns relevant for France and the surrounding area.

This probabilistic model is introduced by testing its robustness and accuracy with rainfall data from France, Spain and Switzerland, using 37 long data series for the period 1904-2003, and a regional data set of 478 rain gauges for the period 1954-2005. Two complementary aspects are investigated : the robustness of the estimation of extreme quantiles and associated confidence intervals, and the accuracy of the model considering the observed extreme values. Comparison with standard probabilistic models demonstrated that the proposed probabilistic model is robust and accurate [2].

This issue will be illustrated through the example of the eastern region of the Pyrenees in southern France, with a very complex climate characterized by a north-south contrast induced by the Pyrenean range but also by a east-west contrast due - among others - to the influence of the Mediterranean on the genesis and intensification of rainy events [3].

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2:30-3:45 Session 11A continued

Modeling hurricane winds with quantile regression

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Keywords:

Quantile regression is employed to model extreme hurricane winds a□ecting the U.S. coast conditional on climate variables (covariates). Results show that the inuence of Atlantic sea-surface temperature, the Pacific El Ni~no, and the North Atlantic oscillation on near-coastal tropical cyclone winds are in the direction anticipated from previous studies using generalized linear models and are generally strongest for higher wind speed quantiles. The inuence of solar activity, a new covariate, peaks near the median wind speed level, but the relationship switches sign for the highest quantile winds. An advantage of the quantile regression approach over a more traditional parametric extremevalue model is that it is easier to interpret the model coefficients (parameters) in terms of variations in covariates since coefficients Vary as a function of quantile. We compare this modeling approach to a similar approach using a peaks over threshold model. It is shown That while quantile regression coefficients are independent of the covariate and functionally dependent on the quantile, the extreme-value Model coefficients are functionally dependent on the covariate and independent of the quantile.

Time Varying Structures for Extreme Values

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GEV distribution; time-varying parameters; DLMs; AR models; Bayesian model comparisons:

We propose and review different approaches to study non-stationary behavior for extreme values. We focus on the Generalized Extreme Value (GEV) distribution and use Dynamic LinearModel (DLMs) and autoregressive structures, to allow for time changes in model parameter. In particular, some of our models are capable of estimating the shape parameter of the GEV distribution in a time-varying fashion. We propose customized Markov Chain Monte Carlo (MCMC) methods to approximate posterior inference of quantities of interest such as quantiles. The methodology is illustrated with environmental and meteorological observations of extreme events such as daily maximum ozone levels or annual maximum sea-levels. The different model structures and time-varying parameterizations are compared with Bayesianmodel selection approaches such as approximate Bayes Factors and the Deviance Information Criteria (DIC).

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2:30-3:45 Session 11A continued

Multidimensional trends and extremes with application to temperatures in Europe

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Keywords: multidimensional trends; extremes; K hypothesis; non-parametric

We address first the K hypothesis : for a non stationary times series X the centered (by the mean) and normalized (by the variance root) data Y has stationary extremes (the parameters of the extreme models of Y_t are constant). We avoid focusing on the possible weak deformations in the center of Y_ts distribution and look only to tails stationarity. The GEV model is considered. We propose a new method to test K using as a statistic the estimated L_2 distance between a constant estimator and a non parametric (non-stationary) estimator obtained by splines for instance and a choice of smoothing parameter by cross-validation is used to guarantee the good estimates. A theoretical analysis of the power of the test is done using asymptotic of contrasts functions.

The K hypothesis is studied on the 55 series of temperature in Europe for both seasons: summer and winter and show That K is satisfied in a large part of Europe.

We propose also a careful analysis between the dependence of four trends general and extremes mean and variance.These results and not only those on extremes are used to evaluate the performances of some numerical models and also to get stochastic modelling.

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2:30-3:45 Session 11B

Computational Measure-Theoretic Method for Posterior Density Estimation

Troy Butler (speaker) Colorado State University, USA, butler@math.colostate.edu

Dr. Don Estep Colorado State University, USA

Inverse Sensitivity; Bayesian Inference; Posterior Density; Sensitivity Analysis:

We consider the inverse problem of quantifying the uncertainty of inputs to a finite dimensional map, e.g. determined implicitly by solution of a nonlinear system, given specified uncertainty in a linear functional of the output of the map. The uncertainty in the output functional might be suggested by experimental error or imposed as part of a sensitivity analysis. We describe this problem probabilistically, so that the uncertainty in the quantity of interest is represented by a random variable with a known distribution, and we assume that the map from the input space to the quantity of interest is smooth. We derive an efficient method for determining the unique solution to the problem of inverting through a many-to-one map by inverting into a quotient space representation of the input space which combines a forward sensitivity analysis with the Implicit Function Theorem. We then derive an efficient computational measure theoretic approach to further invert into the entire input space resulting in an approximate probability measure on the input space.

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EXTREME LEVEL CURVES OF HEAVY-TAILED DISTRIBUTIONS

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Conditional quantiles; heavy-tailed distributions; kernel estimator; extreme values:

We address the problem of estimating quantiles of a variable of interest $Y \in I\!R$ when a covariate information $X \in I\!R^d$ is available. Let (X_i, Y_i), $i = 1, \ldots, n$ be independent copies of the random pair (X, Y) and denote by $\bar{F}(.|x)$ the conditional survival function of Y given $X = x$. The generalised inverse of the conditional survival function is denoted by $\bar{F}^{\leftarrow}(.|x)$. Our aim is to estimate the small tail probability $\bar{F}(y_n|x)$ when y_n goes to infinity with the sample size n and the extreme conditional quantile $q(\alpha_n|x) = \bar{F}^{\leftarrow}(\alpha_n|x)$ where $\alpha_n \to 0$ as $n \to \infty$. In this paper, we focus on the case where the conditional distribution of Y given $X = x$ is heavy-tailed with tail index $\gamma(x) > 0$. When no covariate information is available, these problems have been extensively studied (see e.g. [2]). In our situation, we propose to estimate the survival function by its kernel estimator [1] defined for all $(x, y) \in I\!R^d \times I\!R$ by:

$$\hat{\bar{F}}_n(y|x) = \sum_{i=1}^{n} K((x - X_i)/h)\mathbb{1}\{Y_i \geq y\} \Bigg/ \sum_{i=1}^{n} K((x - X_i)/h),$$

where $\mathbb{1}\{.\}$ is the indicator function and $h = h_n$ is a non random sequence such that $h \to 0$ as $n \to \infty$. The kernel function $K(.)$ is a bounded point distribution function on $I\!R^d$ with a support S included in the unit ball of $I\!R^d$. We then propose to estimate the small tail probability $\bar{F}(y_n|x)$ by $\hat{\bar{F}}(y_n|x)$ and the extreme conditional quantile by $\hat{q}_n(\alpha_n|x) = \hat{\bar{F}}_n^{\leftarrow}(\alpha_n|x)$. Under mild regularity conditions, we prove that the small tail probability estimator is asymptotically Gaussian if y_n converges not too fast to infinity *i.e.* if $nh^d\bar{F}(y_n|x) \to 0$. We also prove that the conditional quantile estimator is asymptotically Gaussian if α_n converges to 0 at a lower rate than nh^d. These results are illustrated on simutated datasets.

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2:30-3:45 Session 11B

Spatio-Temporal Gaussian Models and their level crossings distributions

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spectral density, covariance function, stationary second order processes, Rice formula:

We discuss spatio-temporal random fields introduced through a spatial correlation structure that accounts for dynamic evolution in time. We start with homogenous spatial fields and by applying an extension of the standard moving average construction we arrive to stationary in time models. Then, we depart from the homogeneity-in-space condition by allowing slow space variation of parameters of homogeneous fields. In a similar manner, we extend to non-stationary in time models. We also study the consequences for spatio-temporal dependence structure that follows from composing the field with dynamical flow governed by a velocity field. For the so introduced models statistical distributions of characteristics sampled at spatio-temporal level crossings are obtained through generalized Rice's formula. Applicability of the models is illustrated by models of significant wave heights over large areas of the sea and along a sea voyage. We also present how, through such an approach, large scale data can be integrated with the local data to build a consistent multiscale model.

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Thursday, June 25

2:30-3:45 Session 11B

Confidence Regions for Level Curves

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Suppose we observe responses $z(s_1), \ldots, z(s_N)$ of a single realization of a continuous Gaussian random field Z, where $s_1, \ldots, s_N$ are locations in the two-dimensional region of interest $\mathcal{D} \subset \mathcal{R}^2$. Our interest lies in constructing a confidence region S for the level curve $I_u = \{s : Z(s) = u\}$ for this particular realization such that $\Pr(I_u \subseteq S)$ is $1 - \alpha$. Our method is based on multiple hypothesis testing in which the critical value of the test is adjusted to control the simultaneous Type I error rate.

Instead of finding S directly, we seek to construct a set E which does not intersect I_u with guaranteed confidence so that $\Pr(\{E \cap I_u\} = \emptyset) \geq 1 - \alpha$. Consequently, the set $S = E^c$ since $\Pr(I_u \subseteq E^c) \geq 1 - \alpha$. The set E can be constructed by testing $H_0 : Z(s) = u$ versus $H_a : Z(s) \neq u$ at locations s throughout the domain of interest and letting E be the set of locations for which the null hypothesis is rejected. To make the scale of the problem more manageable, $\mathcal{D}$ is divided into n rows and n columns of small, equal sized "pixels". The center of each pixel is taken to be a be a good representative of the process over the pixel and hypothesis tests are performed at the center of each pixel. We construct a test statistic using kriging which has a standard normal distribution. Since there are numerous hypothesis tests, we seek to adjust for multiple comparisons and control the simultaneous Type I error rate by picking an appropriate critical value C_α. The set E is taken to be the union of all pixels for which the null hypothesis is rejected at the centerpoint.

We approximate the critical value C_α by considering the distribution of the maximum of a triangular array of stationary Gaussian random fields $X_n = \{\xi_{i,j,n}\}_{i,j=1}^n$ with $\xi_{i,j,n}$ having mean 0 and variance 1. Using analogues of the conditions in [1] for random fields, which allows for strong local dependence among variables but asymptotic independence, the maximum of X_n exhibits extremal clustering in the limit. A formula for the extremal index $\theta < 1$ that governs the clustering is provided.

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Thursday, June 25

2:30-3:45 Session 11B

Fiducial Inference on the Maximum Mean of a Multivariate Normal Distribution

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Jan Hannig) University of North Carolina, USA

Fiducial inference; maximum mean; asymptotic consistency; importance sampling:

Inference on the maximum mean of a multivariate normal is a common difficult problem. This is a relatively unexplored topic and we will be proposing a method that involves inference techniques based on an extension of R. A. Fisher’s fiducial inference methods. We used a fiducial based model for the maximum mean and conducted a simulation study to show that this method possesses promising empirical properties. We also proved that the fiducial based confidence intervals have asymptotically correct coverage. This type of inference on the maximum mean of a multivariate normal can show up in a variety of situations. We will apply our method to an example that is based on the air quality index of the four largest cities in the northeastern United States (Baltimore, Boston, New York, and Philadelphia).

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4:15-6:15 Session 12

Assessing Human Influence on Extremes

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Climate change; weather and climate extremes; detection and attribution; day-count indices:

This paper will first review approaches that have been used to date to detect changes in the frequency and/or intensity of extremes, and attribute causes. It will then discuss possible approaches to make further advances in this area. Most work to date has relied on the analysis of day-count indices, such as time series of the annual frequency of exceedance above a moderately high threshold. A typical example of such an index is the TX90p index, which counts the number of days annually with maximum surface air temperature above the 90th percentile of daily surface air temperature observations. Detection studies using such indices have determined, for example, that human influence on the climate system has affected the frequency of cold nights, cold days and warm nights. Some recent work has also used other approaches, for example, using climate models to assess a change in risk of a defined event after having detected and attributed change in the mean state, or by applying detection and attribution techniques to the analysis of trends in the parameters of extreme value distributions fitted to time series of observed extremes. External influence on extremes will become increasingly detectable over time as the response to anthropogenic forcing of the climate continues to manifest itself and signal-to-noise ratios increase. In addition, it should be possible to increase the detectability of external influence on the frequency and intensity of rare events by further integrating the application of extreme value theory into detection and attribution studies. This may allow earlier detection of anthropogenic influence on extremes, and would help to inform adaptation planning by providing useful constraints on projected changes in extremes.

4:15-6:15 Session 12 continued

The influence of large scale climate variability on winter maximum daily precipitation over North America

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GROISMAN, PAVEL NCDC, USA

Generalized Extreme Value Distribution; Maximum Daily Precipitation; North America:

The generalized extreme value (GEV) distribution is fitted to winter season daily maximum precipitation over North America, with indices representing the El Niño/Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), and the North Atlantic Oscillation (NAO) as predictors. It was found that ENSO and PDO have spatially consistent and statistically significant influence on extreme precipitation while the influence of NAO is sporadic and is not field significant. The spatial pattern of extreme precipitation response to large-scale circulation variability is similar to that of total precipitation but somewhat weaker in terms of statistical significance. An El Niño condition or high phase of PDO corresponds to an increased risk in extreme precipitation over a vast region of southern North America, but a decreased risk of extreme precipitation in the north, especially in the Great Plains and Canadian Prairies and the Great Lakes/Ohio River valley. During El Niño years, an extreme daily precipitation event that occurs once in every 20 La Niña years may occur more than twice as often in extended region of southern North American but much reduced frequency in the Prairies.

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4:15-6:15 Session 12 continued

Nonparametric Spatial Models for Extreme Temperature Data.

Montserrat Fuentes- North Carolina State University

Estimating the probability of extreme temperature events is difficult because of limited records across time and the need to extrapolate the distributions of these events, as opposed to just the mean, to locations where observations are not available.
Another related issue is the need to characterize the uncertainty in the estimated probability of extreme events at different locations.
In this work, in order to make inference about spatial extreme events, we introduce two new models. The first one is a Dirichlet-type mixture model, with marginals that have generalized extreme value (GEV) distributions with spatially varying parameters, and the observations are spatially-correlated even after accounting for the spatially varying parameters. This model avoids the matrix inversion needed in the spatial copula frameworks, and it is very computationally efficient. The second is a Dirichlet prior copula model that is a flexible alternative to parametric copula models such as the normal and t-copula. This presents the most flexible multivariate copula approach in the literature.
The proposed modelling approaches are fitted using a Bayesian framework that allow us to take into account different sources of uncertainty in the data and models.
We apply our methods to annual maximum temperature values in the east-south-central United States.

Friday, June 26

8:30-10:00 Session 13

Limit Theorems for Empirical Processes of Cluster Functionals

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empirical processes, cluster functionals, extremal dependence, stationary processes, mixing, ¯nitedimensional convergence, tightness

Large values of stationary sequences often occur in clusters. This talk is about empirical limit theory for these clusters. The concept of a "core", and classes of functions which only depend on cores are central ingredients: time is divided up into blocks, and the core of a block are the values in the smallest interval which contains all large values in the block. We obtain uniform central limit theorems for classes of functions de¯ned on cores. The conditions for convergence include β-mixing at a suitable rate, convergence of covariances, and restrictions on the sizes of the classes of functions, in terms of bracketing entropy, random entropy, or VC-class theory. Applications include cluster lengths, multivariate tail empirical processes, and classes of indicator functions. Holger Drees has used these results to strengthen earlier results on extremal index estimation, and in particular to gain deeper insight into the in°uence of the choice of threshold on asymptotic behavior. He will present these results in another talk in this conference.

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Friday, June 26

8:30-10:00 Session 13

INFERENCE ON COPULAS: WHEN IGNORANCE IS BLISS

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Asymptotic variance; extreme-value copula; empirical process; left-tail decreasing; Pickands dependence function; concordance; rank-based inference.

The study of the empirical copula goes back to at least the work of Rüschendorf (1976), with subsequent fundamental contributions by Stute (1984), Fermanian et al. (2004) and Tsukahara (2005). In Genest and Segers (2009a), the following observation was made: for bivariate extreme-value copulas, the empirical copula process has a smaller asymptotic covariance function than the ordinary bivariate empirical process. The remarkable consequence is that even if the marginal distributions are known, a better estimator of the Pickands dependence function arises if the marginal distributions are treated as unknown and estimated nonparametrically instead. Heuristic computations in Charpentier et al. (2007) point in the same direction but for more general copula families.

In Genest and Segers (2009b), it is shown that if each variable is left-tail decreasing in the other one, then indeed the empirical copula process has a smaller asymptotic covariance function than the standard bivariate empirical process. For such copulas, copula parameters that are increasing functions of the copula with respect to the concordance ordering are estimated more efficiently when knowledge on the marginal distributions is ignored and ranks are used instead. Examples include concordance measures such as Spearman's rho and Gini's gamma.

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Friday, June 26

8:30-10:00 Session 13

An M-Estimator of Tail Dependence in Arbitrary Dimensions

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asymptotic properties; M-estimation; multivariate extremes; tail dependence:

Let $X_1, \ldots, X_n$ be a d-dimensional random sample from a distribution function F, $d \geq 2$, and let F be in the max-domain of attraction of an extreme-value distribution. Under the assumption that the stable tail dependence function, l, of F belongs to a given parametric model, we propose an M-estimator for the parameter of l.

The estimator is dened as the value of the parameter vector that minimizes the distance between a vector of weighted integrals of the tail dependence function on the one hand and empirical counterparts of these integrals on the other hand. Under minimal conditions, this minimization problem has (with probability tending to one) a unique, global solution. The estimator is consistent and asymptotically normal. Since no assumptions on the di□erentiability of the stable tail dependence function are made, the method can be used for discrete models as well.

This estimator is an extension of the one proposed in [1] in two respects: the dimension of the data is now arbitrary, and the number of moment equations can exceed the dimension of the parameter space.

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10:30-12 Session 14A

Models for dependent extremes using stable mixtures

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multivariate extreme value distributions; positive stable distributions

A class of dependent multivariate extreme value (EV) models from [1] is described. The approach uni¯es and extends the logistic models developed by various authors. These models have the appealing property that both unconditional and conditional distributions are themselves EV distributions, and all lower-dimensional marginals and maxima belong to the class.

The models are built by mixing independent EV distributions with multivariate dependent positive stable laws. The mixing variables are used as a modeling tool and for better understanding and model checking. Extreme value analogues of components of variance models, and new time series, spatial, and continuous parameter models for extreme values are described.

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Friday, June 26

10:30-12:00 Session 14A

Cointegration in continous-time with applications in finance

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cointegration; estimation; heavy tailed; L´evy process; Ornstein-Uhlenbeck process; point process; regular variation; stable distribution:

Empirical studies of financial time series, as exchange rates, foreign currency spot and future rates or different interest rates in different countries, show that they are cointegrated. That means that each time series is integrated but a linear combination of these integrated processes is stationary. This concept goes back to the seminal work of Granger (1981) and Engle and Granger (1987). Since a stylized fact of financial time series are heavy tails we consider a cointegration model in continuous-time where the linear combination of the integrated processes is modeled by a multivariate regularly varying Ornstein-Uhlenbeck process. We present estimators for the cointegration parameters and show that they are consistent and asymptotic stable.

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Friday, June 26

10:30-12:00 Session 14A

THE MULTIVARIATE ORNSTEIN-UHLENBECK TYPE STOCHASTIC VOLATILITY MODEL AND ITS TAIL BEHAVIOUR

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L´evy process, matrix subordinator, multivariate regular variation, positive semi-definite Ornstein-Uhlenbeck (OU) type process, OU type stochastic volatility model

In this talk we discuss a multivariate extension of the popular Ornstein-Uhlenbeck type stochastic volatility model of [1].

First, Ornstein-Uhlenbeck type processes taking values in the positive semi-definite matrices are defined using matrix subordinators (special matrix-valued L´evy processes) and a special class of linear operators. Naturally these processes can be used to describe the random evolvement of a covariance matrix over time and we therefore use them in order to define a multivariate stochastic volatility model for financial data. For this model we show that the conditional characteristic function can be calculated explicitly and we derive results regarding the second order structure, especially regarding the returns and squared returns. Finally, we analyse the tail behaviour when the driving L´evy process is multivariate regularly varying. Here, we show in particular that typically the volatility process is tail equivalent to the driving L´evy process.

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Friday, June 26

10:30-12:00 Session 14B

Coverage Accuracy For a Mean Without Third Moment

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Coverage accuracy; Edgeworth expansion; mean; t-statistic:

For constructing a confidence interval for the mean of a random variable with a known variance, one may prefer the sample mean standardized by the true standard deviation to the Student’s t-statistic since the information of knowing the variance is used in the former way. In this paper, by comparing the leading error term in the expansion of the coverage probability, we show that the above statement is not true when the third moment is infinite. Both our theory and simulation prefer the Student’s t-statistic either when one-sided confidence intervals are considered for a heavier tail distribution or when two-sided confidence intervals are considered. Unlike other existing expansions for the Student’s t-statistic, the derived explicit expansion for the case of infinite third moment can be used to estimate the coverage error so that bias correction becomes possible.

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HILL ESTIMATOR FOR TEMPERED POWER LAWS

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MARK MEERSCHAERT *Michigan State University, USA*
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Tail estimation; Hill estimator; Exponential tempering; Tempered stable:

A random variable X is said to follow a tempered power law if $P(X > x) = L(x)x^{-\alpha}e^{-\beta x}$ for all $x > 0$, where $\alpha, \beta > 0$ and L is a slowly varying function. These laws behave like a power law in the short time frame and decay exponentially fast in the long time frame. They arise in many applications like statistical physics, finance, hydrology, atmospheric science etc. Tempered stable law considered by Rosinski (2007), the tempered Pareto distribution, etc. are examples of such distributions.

In this talk, we suggest a method of estimating the parameters for these laws using a conditional maximum likelihood approach in parallel to Hill (1975) and discuss the asymptotic properties of the estimates. We also consider a triangular array of random variables having tempered power law with the same tail parameter α and the tempering parameter β deceasing to zero. In this set up, we show that the Hill estimator of α is consistent provided the number of upper order statistics used is chosen carefully. These asymptotic results will be supported by a simulation study from a tempered stable distribution and the methods will be demonstrated using a data set from geophysics that show a power law tail with some tempering.

This talk is based on a joint work with Mark Meerschaert and Qin Shao and an ongoing joint work with Arijit Chakrabarty.

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Friday, June 26

10:30-12:00 Session 14B

Representation of the Fragility Index by norms

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Fragility Index; Dependence structure; Systemic stability; Multivariate Extreme Value Analysis:

The stability of a network like the financial system can been characterized by a measure called the Fragility Index FI(k). This is the limit of the expected total number of exceedances over a high threshold among d random variables $Q_1,\ldots,Q_d$ as the threshold increases, given that there are at least k exceedances. Hence the FI describes the dependence structure in a multivariate framework, where usually the concept of copulas is applied. We, therefore, continue work of Geluk, De Haan and De Vries (2007), who considered the case k = 1.

We assume that the distribution function F of the vector Q = $(Q_1,\ldots,Q_d)$ is in the domain of attraction of a multivariate extreme value distribution (EVD) G. It is known that an EVD can be represented by means of a norm. From this we deduce a closed representation of FI(k) by norms. This entails in particular that the FI does not depend on the margins of F if the Q_i are identically distributed.

If Q follows a multivariate Generalized Pareto distribution, then the FI already attains its limit for a finite threshold.

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10:30-12:00 Session 14B

A UNIFIED STATISTICAL MODEL FOR PARETO AND WEIBULL TAIL DISTRIBUTIONS

GIRARD, Stéphane (speaker) ***INRIA Rhône-Alpes, France***, Stephane.Girard@inrialpes.fr
GARDES, Laurent *INRIA Rhône-Alpes, France*
GUILLOU, Armelle *University of Strasbourg, France*

Distribution tail; extreme quantile; maximum domain of attraction; asymptotic normality:

We propose a new model of distributions depending on a function φ and on a positive parameter θ called the φ-tail coefficient. We define the cumulative distribution function F of our model by

$$1 - F(x) = \exp\left\{-\varphi^{\leftarrow}(\log(x^{1/\theta}\ell(x)))\right\}, \text{ for } x \geq x^*,$$

where $\theta > 0$, ℓ is a slowly varying function, φ is an increasing function such that $\varphi(x) \to \infty$ as $x \to \infty$ and $\varphi^{\leftarrow}$ denotes the generalised inverse of φ. For instance, one can choose the function φ such that $\varphi'(x) = x^{\tau}$ where $\tau \in [-1, 0]$. In this case, the tail heaviness of F is controled by the parameters τ and θ: the larger τ or θ are, the heavier is the tail. For example, if $\tau = 0$, F is an heavy-tail distribution with tail index θ and if $\tau = -1$, F is a so-called Weibull-tail distribution with Weibull-tail index θ. Recall that Weibull-tail distributions belong to the maximum domain of attraction of Gumbel and encompass for example the normal, gamma and exponential distributions.
For a given function φ, we propose estimators of the φ-tail index θ and of the extreme quantile x_{p_n} defined by $F^{\leftarrow}(x_{p_n}) = 1 - p_n$, where $p_n \to 0$. Note that usually, x_{p_n} is larger than the maximum observation of the sample. This necessity to extrapolate sample results to areas where no data are observed occurs for instance in reliability, hydrology, finance, ... Our estimator of θ consists in averaging the log-spacings between the upper-order statistics. It only depends on φ through a multiplicative normalizing constant. The extreme quantile estimator is an adaptation of the Weissman estimator [4] to our more general model. Under mild conditions on φ and on the slowly varying function ℓ, we establish their asymptotic normality. In the particular case where $\varphi'(x) = x^{\tau}$ with $\tau \in \{-1, 0\}$, our estimators coincide with classical ones proposed in the literature (see [1], [2] when $\tau = -1$ and [3], [4] when $\tau = 0$) thus permitting to retrieve their asymptotic normality in an unified way.

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Friday, June 26

10:30-12:00 Session 14B

Detecting Structural Breaks in Tail Behavior From the Perspective of Fitting the Generalized Pareto Distribution

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test for structural change; exchange rate regime; generalized Pareto distribution; tail index; extreme value theory :

Extreme value theory is heavily applied in modeling tail behavior especially when computing the risk measures in the lower tail. Previous literature uses the tail index to test for structural breaks in the tails. This study relies on the outperformance of the generalized Pareto distribution (GPD) in modeling tails. The transformed GPD is treated as a classical ordinary least square regression and four major tests are applied to detect the existence and the number of structural break(s): supLM test (Andrews and Ploberger 1994), OLS-based CUSUM test (Ploberger and Kramer 1992), Nyblom-Hansen test (1989; 1992), and generalized M-□uctuation test Zeileis (2006). The outcomes indicate that there are multiple structural breaks at extremal quantile levels of all the three exchange return series considered (UK pound, Japanese Yen, and New Taiwan Dollar, all vs. US Dollar). It is advised that EVT should be used with caution for risk management purposes.

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10:30-12:00 Session 14B

The Tail Probability of Stochastically Discounted Aggregate Claims with Subexponential Tails

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Asymptotics; L´evy process; Risky investment; Subexponentiality

We consider the classical risk model in which claims, arriving according to a homogenous Poisson process, form a sequence of independent random variables with common subexponential distribution. The insurer is allowed to make riskless and risky investments and the price process of the investment portfolio is modeled as an exponential L´evy process independent of the insurance process. We derive an exact asymptotic formula for the tail probability of stochastically discounted aggregate claims by a fixed time. In doing so, we discover some properties of subexponential distributions, which are of independent interest.

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1:30-3:00 Session 15A

Rare events in tandems of queues with heavy-tailed distributions

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Subexponential distributions; tandem of queues; asymptotics for the stationary sojourn time; multi-server queue:

Consider a stable tandem of m FIFO single-server queues, $GI/GI/1 \to GI/1 \to \ldots \to GI/1$. I assume service times in queues to be heavy-tailed (subexponential) and plan to discuss the tail asymptotics for the distribution of the stationary sojourn time in each queue and also for some joint distributions. SImilar results for a tandem of two servers have been obtained in [1, Section 6].

Also, the tail asymptotics for stationary waiting (sojourn) times in multi-servers queues and multi-server queues in tandem will be considered. This is a continuation of studies from [2] where a two-server queue has been studied.

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Rare-event Simulation for Gaussian Random Fields

Liu, Jingchen (speaker) Columbia University, U.S.A., jcliu@stat.columbia.edu

Jose Blanchet Columbia University, U.S.A.

Robert J. Adler Technion-Israel Institute of Technology, ISRAEL

Gaussian random field; rare-event simulation; importance sampling :

In this talk, we present an algorithm to efficiently compute the tail probabilities for the maxima of Gaussian random fields. In particular, we focus on twice differentiable and stationary fields living in a compact subset of R^d. The simulation of random fields requires discretization. As the probability of interest becomes smaller, the discretization should be finer in order to control the relative bias. The efficiency analysis of this importance sampling algorithm takes advantage of the structures of the random fields around local maxima and area of the excursion set. These properties depend heavily on differentiability and the expansion of the covariance function around origin. More interestingly, the nature of this problem and techniques employed for the simulation design are closer to those of heavy-tailed systems although everything is multivariate Gaussian.

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Friday, June 26

1:30-3:00 Session 15A

Rare-event Simulation Techniques

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Leder, K. *Columbia University, USA.*
Li, C. *Harvard University, USA.*

Importance sampling; Rare-event simulation; Regularly varying tails; Gaussian processes:

This talk is based on several projects. We will discuss some techniques that deal with efficient estimation via simulation of rare event probabilities. Namely, probabilities of the form $\alpha_n = P_n(A_n)$ so that $\alpha_n \longrightarrow 0$ as $n \to \infty$ (n is some large deviations parameter).

We concentrate on multidimensional stochastic processes with regularly varying tails and systems with complex correlations structures, such as long range dependence. A simulation estimator, Z_n (we work with a single replication of the estimator) for α_n is said to be efficient if by averaging i.i.d. replications of Z_n one can obtain an estimator whose relative mean squared error can be arbitrarily reduced at the expense of a computational cost (which includes the number of replications) that scales polynomially in $\log(1/\alpha_n)$ as $n \to \infty$.

In the context of multidimensional stochastic processes, we discuss a class of algorithms based on mixtures and on scaling ideas that are efficient to estimate the distribution of first-passage time probabilities in stochastic recursion equations of the form $X_{n+1} = A_{n+1}X_n + B_{n+1}$, where the B_n's are regularly varying vectors and the A_n's (which are assumed to be i.i.d. and independent of the i.i.d. sequence of B_n's) are suitably light-tailed compared to the B_n's. The discussion is based on [1].

In the setting of processes with long range dependence, we present a class of algorithms that allow to estimate the tail of the maximum of Gaussian processes with regularly varying drift and variance with complexity that is polynomial in the size of the tail parameter. The polynomial complexity is explicitly characterized by the regularly varying index of the drift process and the method is applicable to arbitrary correlation structures. The presentation is based on [2].

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1:30-3:00 Session 15B

Using Time Varying Extreme Value Models In The Construction of A Financial Factor Model

Labovitz, Mark L. (speaker) Thompson Reuters, USA, mark.labovitz@thomsonreuters.com

The author extended a time varying extreme value model for returns from a global distributed sample of publically trade securities, namely equities. The initial dataset included 85,000+ securities traded on 80+ exchange world wide for the years 2000-2007. Daily performance measures examined include price, return, volume, free oat market capitalization. Ancillary data elements include, geography (headquarters geography versus security trade-area geography), stock exchange, sector and year. The performance time series were ltered for missing values, length, recently of values (with respect to 2007), availability of ancillary data elements and liquidity. The resultant data set was subjected to a stratified random sample for further analysis. A block maxima (-1*minima) model was imposed to compute a weekly minima series of return observations. Time varying GEV (Generalized Extreme Value)distributions were fitted to the return series.

To this end the parameters of the GEV distributions for the transformed minima equity returns are estimated as a function of 139 financial series. Using the results from these models, the investigator produced a set of time varying return values which represent quantiles of the distribution for a given return level.

Using a step-wise selection approach, the return level vector of global securities of return values was then modeled as a Gaussian process which incorporated the factors of market capitalization, stock exchange and industrial sector.

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Friday, June 26

1:30-3:00 Session 15B

RISK CONCENTRATION OF EXTREME EVENTS UNDER SECOND-ORDER REGULAR VARIATION

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Aggregation; Diversification; Risk Concentration; Second-Order Regular Variation:

Diversification is one of the most popular techniques to mitigate exposure to extremely high risks in all areas of banking and (re-)insurance. Traditionally, many banks and insurance companies have based their business model on the concept of diversification (reduction of risk concentration) by aggregating risks in rather conservative asset/liability portfolios. Nowadays however, the appearance of complex financial and insurance products makes a proper analysis of portfolio diversification more than difficult.

Many authors have warned against an imprudent application of diversification, when the underlying risk factors show a heavy-tailed pattern, far away from the Gaussian world.

In this paper, we analyze portfolio diversification and risk concentration from a Quantitative Risk Management (QRM) perspective. We discuss asymptotic properties of diversification benefits under the risk measure Value-at-Risk (VaR). The theory of second-order regular variation helps to improve well-known results concerning the aggregation of risks. Our results are written with an emphasis on the new regulatory framework for banks (Basel II) and insurance companies (Solvency II), where diversification within and among market, credit, operational and insurance risk plays an important role.

Diversification benefits due to risk aggregation would certainly be convenient from an economic viewpoint. However, a mathematical justification of a given degree of diversification may be challenging.

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Friday, June 26

1:30-3:00 Session 15B

Probabilistic and Statistical Poperties of Even B-Splines Distributions and Their Applications in Financial Modeling

Amezziane, Mohamed (speaker) ***DePaul University, USA***, mamezzia@depaul.edu
Mohamed Amezziane *DePaul University, USA*

Empirical studies of financial data have identified a set of common features among stock market returns known as stylized facts. These include among others thick tails, asymmetry and aggregated normality. Many distributions have been proposed with the objective of modeling these characteristics. This talk introduces a distribution family that captures asymmetry and thick tails, and has a large range of admissible skewness and kurtosis. Like Mandelbrot and Levy before him, we define and describe this distribution through its characteristic function. This methodology has the advantage of controlling the thickness of the distribution tails through a smoothness parameter of the characteristic function. But unlike Levy's stable distribution, the distribution we propose has a simple characteristic function, an explicitly defined density function, a possibly finite variance and allows the aggregated normality feature. In addition, adaptive nonparametric estimators of the density enjoy a convergence rate of order $\sqrt{n}$. We also present statistical inference related to parameter estimation and goodness-of-fit tests. Theoretical results are supported by an extensive simulation study.

The Use of Penultimate Approximations in Risk Management

Degen, Matthias *Federal Institute of Technology, ETH Zurich, Switzerland*, degen@math.ethz.ch
Embrechts, Paul *Federal Institute of Technology, ETH Zurich, Switzerland*

Penultimate Approximation; Power Normalization; Second-Order Extended Regular Variation:

Enhanced by the global financial crisis, the discussion about accurate estimation of regulatory (risk) capital a financial institution needs to hold in order to safeguard against unexpected losses has become highly relevant again. The presence of heavy tails in combination with small sample sizes (typical for operational risk data) turns estimation at such extreme quantile levels into an inherently difficult statistical issue. The nature of the problem calls for EVT in some or other form. However, the application of methods from the standard EVT toolkit in such situations is not without problems.

From a methodological perspective, it is the framework of Π-variation that is most useful for our purposes, as it allows for a unified treatment of the for quantitative risk management important cases (i.e. tail index $\xi > 0$ and $\xi = 0$). Closely related is the notion of power norming (as opposed to the standardly considered linear norming) of quantiles. The use of different normalizations leads to different second-order asymptotics and it turns out that, in certain cases relevant for practice, judicious choices of a (non-constant) power normalization—instead of a linear or a constant power normalization—may improve the convergence rate in the respective limit results.

Our findings motivate the derivation of new estimation procedures for high quantiles by means of penultimate approximations. The methods proposed are intended to complement, rather than to replace, methods from the standard EVT toolkit and their applications may be useful in situations in which the reliability of standard EVT methods seems questionable (e.g. sparse databases).

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Friday, June 26

1:30-3:00 Session 15B

MARKET RISK – PARAMETRIZATION AND ESTIMATION IN A GENERAL PARETO MODEL WITH TIME VARYING THRESHOLDS

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FRICK, MELANIE University of Siegen, Germany

Event Risk; Bipower variation; Excesses; Generalized Pareto dfs; Parameter estimation:

Market risk factors are assumed to follow jump diffusion processes. Our aim is to model and parameterize the contained jump height distribution given discrete data. Jump returns in time series are identified by a testing procedure, given in literature, which is based on the realized bipower variation. Due to this test jumps are modelled as exceedances over time varying thresholds and generalized Pareto (GP) random variables are used to describe the pertaining excesses. Given a sample of jump data, we start the parameterization by an initial estimation of the time varying thresholds. We continue by applying different estimation procedures to the excesses over these estimated thresholds within the GP model. The performance of the estimations is analyzed by simulations and the appropriateness of the GP model is controlled both visually and by a goodness of fit test. Finally, our methods are applied to time series of stock data belonging to various market sectors.

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Friday, June 26

1:30-3:00 Session 15B

MODELING FINANCIAL MARKET RETURNS WITH A LOGNORMALLY SCALED STABLE DISTRIBUTION

RIMMER, ROBERT H. (speaker), *United States*, rhrimmer@gmail.com

BROWN, ROGER J., *United States*

Financial Market Returns; Stable; Lognormal; Extreme Value;

A stable mixture distribution is presented as a model for intermediate range financial logarithmic returns. The model is developed from the observation of high frequency one minute market returns, which can be well modeled by random noise generated by a stable distribution multiplied by a non-random market parameter, which is a measure of market volatility. The stable distribution has an α parameter of approximately 1.8, for the actively traded ETF, SPY. The daily time series of the scale factor shows strong serial dependence. Nevertheless the daily scale factor over periods of months to years is well fit by a lognormal distribution. Thus intermediate term market simulation and risk modeling can be accomplished with the product of a lognormal random variable and a standardized stable random variable. Although there is not a closed formula for the stable distribution, the mixture distribution and density functions can be approximated by numerical integration. Where ϕ is the stable characteristic function, and λ is a lognormal density, the mixture characteristic function can be given by mcf.

$$\phi(t, \alpha, \beta) = e^{-|t|^{\alpha}\left(1 - i\,\beta\,\mathrm{sgn}(t)\tan\left(\frac{\pi\alpha}{2}\right)\right)}$$

$$\lambda(x, \mu, \sigma) = \frac{e^{-\frac{(\log(x)-\mu)^2}{2\sigma^2}}}{\sqrt{2\pi}\; x\sigma}$$

$\mathrm{mcf}(t, \alpha, \beta, \gamma, \sigma, \delta) = e^{i\delta t}\int_0^{\infty}\lambda(s, \log(\gamma), \sigma)\,\phi(s\,t, \alpha, \beta)\,ds$, where α is the shape parameter of the stable distribution, β is the stable skewness parameter, γ is the median of the scale factor distribution, δ is a location parameter, and σ is the shape parameter of the lognormal distribution fitting the varying scale factor. Numerically it is difficult to fit these parameters to data, but with the large sample sizes provided by intra-day minute data, α can be approximated using the generalized extreme value distribution, and maxima of partitioned data. α can also be approximated by sequentially fitting each day's data; this value is surprisingly consistent, or by rescaling each day's data by the stable γ for the day and performing a stable fit to the rescaled data. The parameters for lower frequency daily returns can be approximated by taking advantage of the serial dependence, estimating the scale factor for partitioned data and rescaling the partitions.

The presentation shows evidence for the model with one minute returns of the SPY ETF collected since July 2007. This time frame includes a rather remarkable variation in market volatility, yet the model seems to remain valid. Calculations of the functions are demonstrated with *Mathematica*, and John Nolan's program, STABLE. A web resource of programs in *Mathematica* will be made available.

The model is attractive since it can account for all the stylized facts about financial returns and be explained as arising from the behavior of a continuous double auction market model that has limit order book return distributions with heavy power-tails, which over very short times measured in seconds yield independent returns obeying the generalized central limit theorem. The varying scale factor or volatility accounts for the serial dependence seen in the absolute value of market returns. The density of the mixture distribution has a higher peak than a stable distribution with the same parameters, α, β, γ, but on the tails it asymptotically approaches a stable distribution. Thus it is different from a truncated stable distribution. Sums of independent random variables from this distribution will converge to a stable distribution, but such behavior may not be observed in financial data because the scaling variables are not independent.

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Friday, June 26

3:30-5:00 Session 16

Bias Reduction for Endpoint Estimation

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Xinping Xu Fudan University, China

Bias reduction; endpoint; extreme value index; order statistics:

Recently Li and Peng (2008) proposed a bias reduction method for estimating the endpoint of a distribution function via an external estimator for the so-called second order parameter. Unlike the same study for the tail index of a heavy tailed distribution, the above procedure requires a certain rate of convergence of the external estimator rather than consistence. This makes the choice of such an external estimator impractical. In this paper, we propose a new bias reduction method which estimates all parameters by using the same number of upper order statistics.

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Friday, June 26

3:30-5:00 Session 16

ESTIMATING EXTREME QUANTILE REGIONS FOR TWO DEPENDENT RISKS

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Density contour; Extreme value; Multivariate quantile; Tail dependence.

When simultaneously monitoring two possibly dependent, positive risks one is often interested in quantile regions with very small probability p. These extreme quantile regions contain hardly or no data and therefore statistical inference is difficult. In particular when we want to protect ourselves against a calamity that has not yet occurred, we take p < 1=n, with n the sample size. We consider quantile regions of the form f(x; y) 2 (0;1)^2 : f(x; y) □ "g, where f is the joint density. Such a region has the property that it consists of the less likely points and that hence its complement is as small as possible. Using extreme value theory, we construct a natural, semiparametric estimator of such a quantile region and prove a refined form of consistency. The results could be applied in, e.g., aviation safety. As an illustration, we compute the estimated quantile regions for simulated data sets.

ON ESTIMATING EXTREME TAIL PROBABILITIES OF THE INTEGRAL OF A STOCHASTIC PROCESS

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KEYWORDS

max-stable processes; tail probabilities; statistics of extremes

ABSTRACT

Let a stochastic process on a space S be in the domain of attraction of some max-stable process. We discuss how to estimate the probability that the integral of the process over the space S exceeds some given high value. For instance, the process might represent the daily rainfall and the integral over S represents then the total daily rainfall over the whole space. We present a consistent estimator for this exceedance probability in a semi-parametric context.

Posters

MODELLING A BIVARIATE DISTRIBUTION WITH HEAVY TAILS

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bivariate distribution; spectral measure; generalized Pareto distribution; mixture model:

The Hybrid Pareto distribution has been introduced in [1] as a way to extend smoothly the Generalized Pareto distribution (GPD) to the whole real axis. The Hybrid Pareto as a component of a mixture model, allows a flexible modelling of the central part of the distribution while inheriting the extrapolation properties of the GPD. The Hybrid Pareto mixture circumvents the need to define where the tail begins (threshold selection for the GPD) and all observations participate in the estimation. In this work, we present a new bivariate distribution which is built in the same spirit: to smoothly introduce a GPD in a bivariate distribution and to let the model determine what is the extremal area. This new distribution, the bivariate Hybrid Pareto, is a bivariate Gaussian of which one direction, as defined by an angle θ, has been transformed to follow an univariate Hybrid Pareto. The idea is to decompose a bivariate distribution into univariate projections with which it is easier to deal. Friedman [2] has proposed such an approach to estimate multivariate density by combining lower dimensional projections. By construction of the bivariate Hybrid, extreme observations are likely to occur along the direction defined by θ. Therefore, there is a direct relationship between θ and the spectral measure [3]. Assuming that extremes occur in a discrete number of directions, a mixture of bivariate Hybrid Paretos would be able to model each direction with heavy tails while providing an estimator of the whole distribution. We explore estimation procedures for the bivariate Hybrid Pareto alone and within a mixture. We first develop algorithms to identify the directions with heavy tails. These estimates can then serve as starting values for maximum likelihood estimation of the bivariate Hybrid parameters.

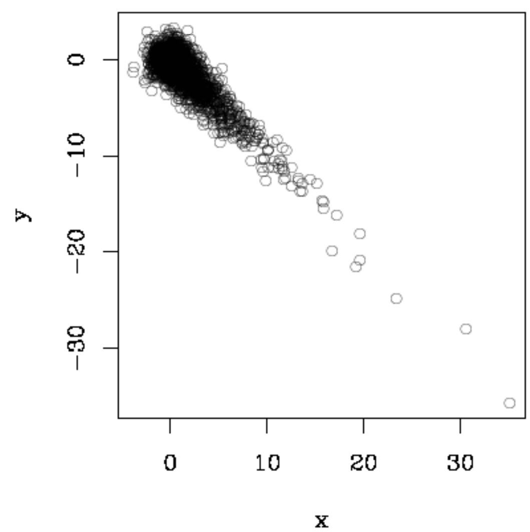

Figure 1: *2000 points sampled from a bivariate Hybrid Pareto with $\theta = \pi/4$*

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A New Perspective on Extremal Dependence: The Example of GARCH Processes

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GARCH; tail chain; extremal dependence measure; extremal index; extremal coefficient function:

Beyond the realm of the extremal index various summary measures have been proposed for stochastic processes in order to characterize properties of clusters of extreme events. In particular, a promising approach for spatial processes termed extremal coefficient function focuses on the dependence structure of maxima in a way analogous to usual (auto-) covariances, cf. Schlather and Tawn (2003).

Our contribution is twofold. First, for univariate processes we present a modification of the extremal coefficient function that characterizes the dependence structure of bivariate extremes subject to the first event initiating the current cluster. Since e.g. in financial applications the first extreme event being the outset of a crisis is in practice observable the new cluster dependence function may make use of this additional information as compared to the extremal coefficient function. We focus on the difference in interpretation of the above characteristics and consider possible applications. Second, we focus on the evaluation of our new dependence measure for GARCH(1,1) processes. To this end, we make use of the fact that the extremes of a Markov chain may be modelled by a certain (back and forth) tail chain, cf. Segers (2007). Its behavior virtually corresponds to a random walk given an extreme observation of the original process as a starting point. A similar approach has been implemented in de Haan et al. (1989) with respect to the extremal index of ARCH processes. In order to evaluate our new characteristic for the GARCH(1,1) class we need to show that the tail chain approach is applicable, see the talk On Some Extremal Characteristics of GARCH Processes by Anja Janß en for details. In particular, also the backwards behavior of the respective tail chain is crucial for our approach. As a by-product we propose a simple evaluation of the extremal index for GARCH(1,1) processes.

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Evolution of Athletic Records: Statistical Effects versus Real Improvements

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Athletic records represent the best results in a given discipline, thus improving monotonically with time. As has already been shown, this should not be taken as an indication that the athletes' capabilities keep improving. In other words, a new record is not noteworthy just because it is a new record, instead it is necessary to assess by how much the record has improved. We derived formulae [2] that can be used to show that athletic records continue to improve with time, even if athletic performance remains constant. Two specific examples, the German championships and the world records in several athletic disciplines have been considered. The analysis shows that, for the latter, true improvements occur in 20–50% of the disciplines.

On kriging of extreme precipitation return levels and tapering

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Climate and Euclidean Space; Kriging; Return levels; Spatial extremes; Tapering and spatially adaptive tapering:

Concerns about environment have become more serious in recent times, and it now almost universally accepted that human activity inuences the climate. The possible e□ects of global warming are still debated, but more and more frequent extreme meteorological events are expected. In order to understand more precisely their causes and likely e□ects, complex numerical simulations of the atmosphere are increasingly combined with statistical analysis.

Extreme value theory, the basic statistical framework used to understand the extreme behaviour of a phenomenon based on an observed time series, provides a way to understand the frequency and the scale of extremes through return levels and return periods. In our work, we focused on a precipitation dataset for the Western United States. The goal was not to study the evolution of extreme precipitation and the di□erence between its present and future behaviour, but to understand its probable future amplitude, frequency and spatial distribution, based on present observations.

Our dataset is output from a regional climate model, that is, a simulation of the weather distribution over our region of study. Given these gridded data, our goal was to compute return levels and to try to smooth this noisy eld via kriging predictors in order to produce a realistic map of return levels. Smoothing in an alternative climate space was also attempted, but the results were not as good as hoped, perhaps because our dataset encompassed a wide and diverse geographical area.

The size of the spatial dataset led to computational problems, and we had to consider covariance tapering in order to reduce the computational burden. The use of this relatively recent method [1, 2] involves the choice of a xed taper range, and part of this work involved extending this framework in order to obtain an ecient spatially adaptive tapering method.

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Wavelet estimation of heavy tails

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Lévy motion; Self-similarity parameter; Log-scale diagram; GLS:

We explore the empirical performance of a semi-parametric wavelet-based estimator of a heavy tail index $\alpha \in (0, 2)$. The estimator was first applied by [1] to estimate α in a linear fractional stable motion (lfsm), and its definition is closely related to that of the wavelet-based GLS estimator ([6]) of the self-similarity parameter $H = d + 1/\alpha$ in a lfsm. When the latter is applied to a Lévy motion (self-similar with $H = 1/\alpha$), the estimator of H yields the estimator of α. Now, consider a sequence $\{X_t\}$ of iid heavy-tailed observations with index α. The partial sums of $\{X_t\}$ converge to a Lévy motion ([3]), hence to estimate α one calculates the wavelet transform of the partial sums of $X_1, X_2, \ldots, X_n$ and then the corresponding wavelet GLS estimator of $H = 1/\alpha$.

This approach is similar in spirit to: i) [2], where it is noticed that the sums of iid heavy-tailed observations over non-overlapping blocks of size m $(m \to \infty)$, $X_k^{(m)} = \sum_{i=(k-1)m+1}^{km} X_i$, $k = 1, 2, \ldots, [n/m]$ scale (approximately) at rate $m^{1/\alpha}$, $X_k^{(m)} =_d m^{1/\alpha} Z$, where Z is an α-stable variable; ii) [5], where the authors use the fact that the maxima of iid heavy-tailed observations over non-overlapping blocks of size m $(m \to \infty)$, $X_k^{(m)} = \max_{(k-1)m+1 \leq i \leq km} X_i$, $k = 1, 2, \ldots, [n/m]$, scale (approximately) at rate $m^{1/\alpha}$, $X_k^{(m)} =_d m^{1/\alpha} Z$ where Z is an α-Fréchet variable. In our case, the wavelet coefficients of partial sums of iid heavy-tailed random variables $W_{j,k}$ scale (approximately) at rate $m^{1/\alpha}$, where $m = 2^j$.

The estimator is simple, computationally fast and unaffected by low-order polynomial trends. It is applied to the realizations generated from a stable, gamma, Fréchet, Pareto and t distributions with tail index $\alpha \in \{0.2, 0.4, \ldots, 1.8\}$ and assessed via RMSE, however the asymptotic theory of this estimator is yet to be established.

Recently, another wavelet-based estimator of a critical order (positive $\lambda^+ = \sup\{r > 0 : E[|X|^r] < \infty\}$, negative $\lambda^- = \inf\{r < 0 : E[|X|^r] < \infty\}$) was proposed by [4], where the local regularity (close to 0) of the characteristic function of X is explored with wavelets.

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A COMPUTATIONAL DIAGNOSTIC FOR THE THRESHOLD IN THE EXTREMAL INDEX ESTIMATION

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Extremal index; Bootstrap; Jackknife; Stationary sequences, Threshold:

In extreme value theory, the extremal index is a parameter of great importance that enables a straightforward extension of the classic extremal results for the independent case to stationary processes. The estimators considered in the literature, despite of having good asymptotic properties, present a high variance for high levels and a high bias when the level decreases, showing then a strong dependence on the high threshold u_n, for finite samples.

A compromise between these two measures is obtained by considering the mean squared error, MSE. A question that has been often addressed is the choice of u_n that minimizes the mean squared error. Then a procedure for selecting that threshold is required.

In the last years resampling methods have been applied to a great variability of situations for helping when nuisance parameters arise and/or when classical approximations are no more valid.

Here, an heuristic approach for estimating the level u_n that asymptotically gives the minimum MSE of an estimator of the extremal index is suggested, based on Lahiri et al. (2003) method. The key idea of the method considers the bootstrap estimation of the variance and the bias of the block bootstrap estimator. The proposed rule is based on the Jackknife-After-Bootstrap (JAB) that yields a nonparametric estimator of the variance of a block bootstrap estimator.

Once obtained an estimate for the optimal block length, an iterative method leads to the estimated optimal threshold.

A simulation study as well as a real case study have been considered. The real data set consists of daily mean river levels from hydrometric station at Fraga, Portugal, during the years from 1946/47 to 1996/97. A subset of this data has already been studied to obtain the estimate of the extremal index, Gomes (1993).

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291-306.

Modelling of Spatial Extremes: A Review

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Composite likelihood; Copula; Environmental data analysis; Spatial extremes:

The areal modelling of the extremes of a natural process such as rainfall or temperature observed at points in space is important in environmental statistics; for example, understanding extremal spatial rainfall is crucial in flood protection. This article reviews approaches to the statistical modelling of spatial extremes, starting with a discussion of geostatistical models and of mathematical models for rare events, based on the notion of max-stability. The main types of models, based on Gaussian anamorphosis, on latent variables, and on the fitting of spatial max-stable processes through composite likelihood methodology, are described and compared on a rainfall dataset.

Ultimate and penultimate models for the reliability of regular and homogeneous series-parallel systems

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series-parallel systems; reliability function; ultimate and penultimate approximation; extreme value theory:

The study of the exact reliability function of thecnological systems, with complex structures, can be an intractable problem. We can find real examples of this kind of systems on transport networks of oil, gas, water and other fluids; also on telecommunication and electrical energy distribution networks and on charge and discharge networks. Usualy, in these cases it is better to admit that the number of system components tends to infinit and find asymptotic models that give a good interpretation of the reliability. However, in certain systems the reliability function, conveniently normalized, can be better approximated by a different reliability function, than by its own limit. Such an approximation is called penultimate or pre-asymptotic and yields an improvement of the convergence rate. In this presentation we will use results in [1] to obtain ultimate and penultimate aproximations for the conveniently normalized reliability function of a regular and homogeneous series-parallel system.

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Spatial Hierarchical Modeling in Comparing Extreme Precipitation Generated by Regional Climate Models

Erin M. Schliep

Using a spatial Baysian hierarchical model, we analyze precipitation output from six regional climate models (RCMs). The primary advantage of this approach is that the model is designed to borrow strength across location by means of a spatial model on the parameters of the generalized extreme value distribution. Being that the data we analyze have a relatively short time span for characterizing extreme behavior but have great spatial coverage, this is particularly important. The hierarchical model we employ is computationally efficient as we have data from nearly 12000 locations. The objective of our analysis is to compare the extreme precipitation generated by these RCMs. Although the RCMs produce similar spatial patterns for the 100-year return level, our results show that their characterizations of extreme precipitation are quite different. We also found differences in the spatial patterns for the point estimates of the extreme value index. These differences, however, may not be significant due to the uncertainty associated with estimating this parameter.

Severe Weather under a Changing Climate: Large Scale Indicators of Extreme Events

Presented by:

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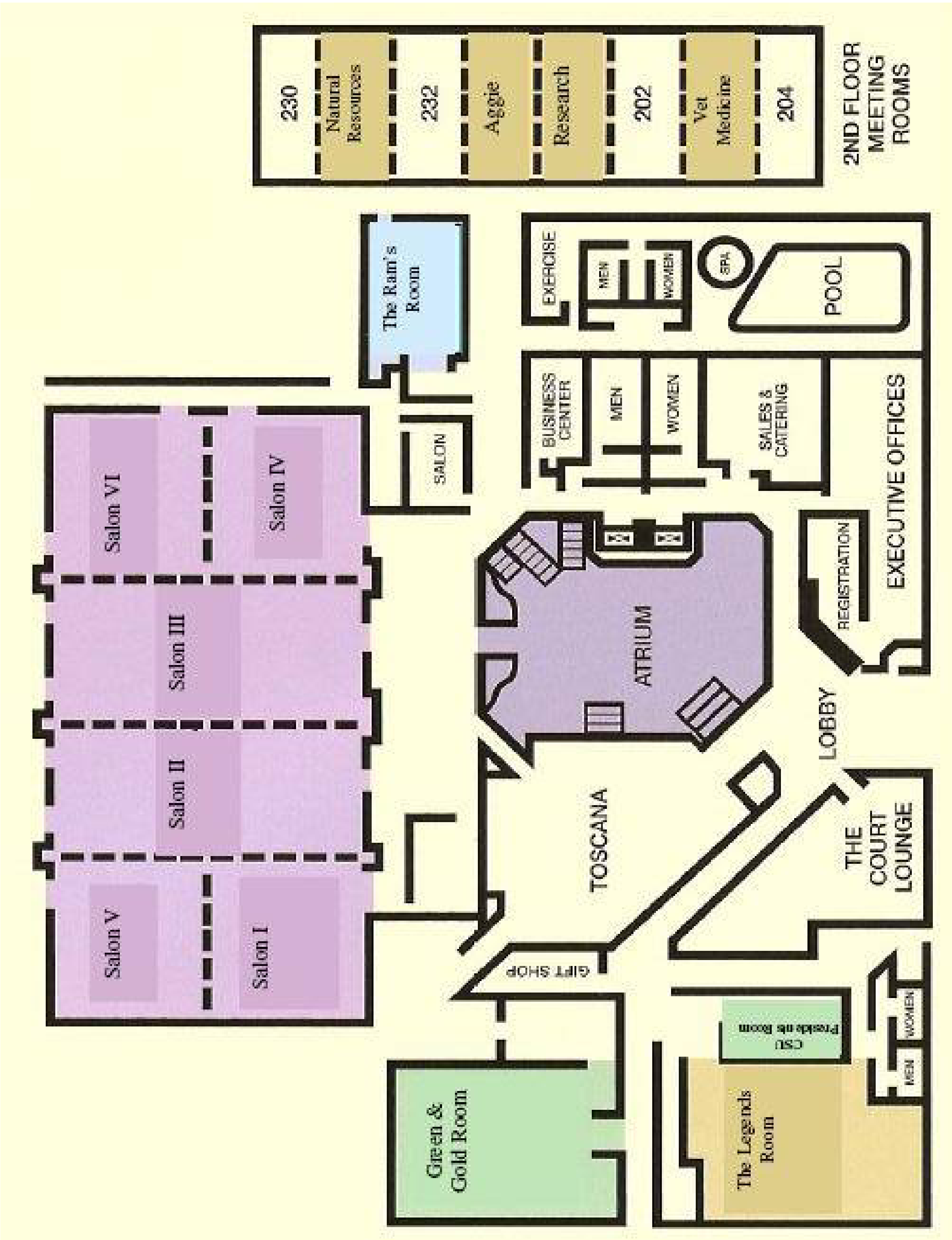
Co-Author:

Eric Gilleland - National Center for Atmospheric Research

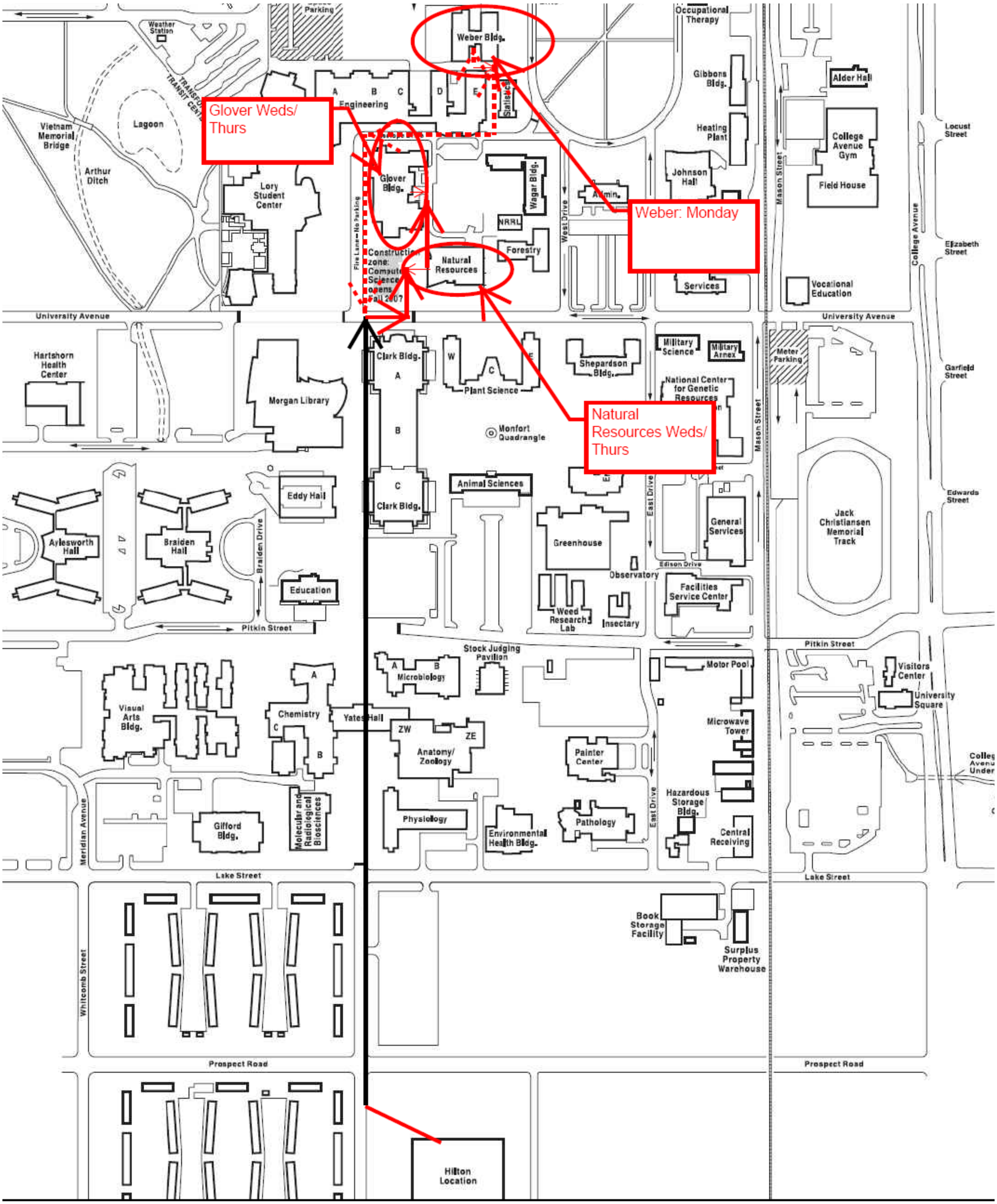
Key Words: severe weather, extreme events, climate change, large scale indicators, fine scale prediction

One of the more critical issues with a changing climate is the behavior of extreme weather events. It is generally thought that such events would increase under a changing climate. However, climate models are currently at too coarse of a resolution to capture the very fine scale extreme events such tornadoes or hurricanes. One approach is to look at the behavior of large scale indicators of severe weather. Here several factors are considered as large scale indicators of severe weather, including convective available potential energy and wind shear. Numerous approaches, including the use of the generalized extreme value distribution for annual maxima, the generalized Pareto distribution for threshold excesses, and a point process approach are examined. Each approach is critiqued and compared for goodness of fit, model robustness, and predictive attributes on re-analysis data with the goal of extending analysis to climate model output data. Acknowledgements to Harold E. Brooks, Patrick Marsh, and Matt Pocernich.

Map of the Hilton Fort Collins



Colorado State University Map



MAP OF FORT COLLINS AREA

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