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Program
# Session Arrangement

(Chair’s name inside the parentheses)

<table>
<thead>
<tr>
<th>Monday (July 8)</th>
<th>Tuesday (July 9)</th>
<th>Wednesday (July 10)</th>
<th>Thursday (July 11)</th>
<th>Friday (July 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>Session-3</td>
<td>Session-7</td>
<td>Session-9</td>
<td>Session-13</td>
</tr>
<tr>
<td>8:30-9:00</td>
<td>8:30-10:15</td>
<td>8:30-10:10</td>
<td>8:30-10:15</td>
<td>8:30-10:15</td>
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<tr>
<td>Opening</td>
<td>I5 (I. Gomes)</td>
<td>C5 (J. Nolan)</td>
<td>I9 (A. Guillou)</td>
<td>I13 (J. Hüsler)</td>
</tr>
<tr>
<td>9:00-9:30</td>
<td>I6 (A. Davison)</td>
<td>C6 (N. Tajvidi)</td>
<td>I10 (J. Segers)</td>
<td>I14 (H. Rootzén)</td>
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<tr>
<td>Group photo</td>
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<tr>
<td>10:30-12:15</td>
<td>Session-4</td>
<td>Session-8</td>
<td>Session-10</td>
<td>Session-14</td>
</tr>
<tr>
<td>I2 (L. Hua)</td>
<td>C1 (J. Liu)</td>
<td>C7 (P. Embretchs)</td>
<td>C9 (P. Naveau)</td>
<td>C13 (C. Zhou)</td>
</tr>
<tr>
<td></td>
<td>C2 (R. Davis)</td>
<td>C8 (V. Fasen)</td>
<td>C10 (A. Ferreira)</td>
<td>C14 (Y. Goegebeur)</td>
</tr>
<tr>
<td>Lunch</td>
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<td>City Tour</td>
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<tr>
<td>I3 (H. Drees)</td>
<td>C3 (Y. Qi)</td>
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<td>C11 (M. Falk)</td>
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<td>I4 (T. Hu)</td>
<td>C4 (Y. Wang)</td>
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<td>C12 (J. Wadsworth)</td>
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<td>I11 (D. Cooley)</td>
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<td>I8 (P. Li)</td>
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<td>I12 (L. Peng)</td>
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Note:

(1) Ixx means an invited session with three speakers; Cxx means a contributed session.
(2) 35 minutes for each invited speaker; 25 minutes for each contributed speaker; 30 minutes for each coffee break;
(3) Registration, opening, lectures and poster take place in Starr Building. Reception is in Crowne Plaza Shanghai Fudan Hotel.
(4) Lunches from Monday to Thursday take place on the 9th floor of Starr Building, while lunch on Friday takes place in Guoding 365 Restaurant.
(5) The size of a poster is no more than 70cm (width) times 140cm (height).
Monday, July 8, 2013

8:30-9:00 Registration (1st floor of Starr Building)
9:00-9:30 Opening (AIA Hall of Starr Building)
   Chair: Deyuan Li
9:30-9:50 Group photo

10:00-10:30 Coffee/Tea break (3rd floor)

10:30-12:15 Session-1 (I1, I2)

Invited Session-I1, Room 301
Title: Applications of Regularly Varying Time Series   Organizer/Chair: Thomas Mikosch
   • Yuwei Zhao, A Fourier analysis of extreme events.
   • Philippe Soulier, Regularly varying time series with asymptotic independence.
   • Olivier Wintenberger, The cluster index of regularly varying sequences with applications to limit
     theory for functions of multivariate Markov chains.

Invited Session-I2, Room 302
Title: Light Tailed and Heavy Tailed Inferences with Applications
Organizer: Zhengjun Zhang   Chair: Lei Hua
   • Hao Zhang, How frequent has the extreme weather become in China?
   • Yizao Wang, Limiting distribution for maximal standardized increment of a random walk.
   • Yongcheng Qi, Penalized maximum likelihood estimation for the endpoint and exponent of a
     distribution.

12:25-13:30 Lunch (9th floor)

14:00-15:45 Session-2 (I3, I4)

Invited Session-I3, Room 301
Title: Extremes for Time Series   Organizer/Chair: Holger Drees
   • Anja Janssen, Refined analysis of asymptotically independent time series models.
   • Rafał Kulik, Estimation of limiting conditional distributions for heavy tailed dependent sequences.
   • Johan Segers, Extremal dependence of Markov chains: walking backwards and forwards in time.

Invited Session-I4, Room 302
Title: 2RV and Dependence   Organizer/Chair: Taizhong Hu
   • Tiantian Mao, Relations between the spectral measures and dependence of multivariate extreme
     value distributions.
   • Xiaoqing Pan, The second-order version of Karamata's theorem with applications.
   • Qing Liu, Closure properties of the second-order regular variation under randomly weighted
     sums.
15:45-16:15 Coffee/Tea Break (3rd floor)

15:45-17:30 Poster Session, 3rd floor

- **Amin, Muhammad**, *GPA: graphical interface based path coefficient analysis*. Co-authors: Wang Xiaoguang, Lixin Song, Muhammad Zubair, Jafar Hussain, and Tila Muhammad.
- **Bormann, Carsten**, *Decomposing multivariate tail risks: When tail correlations are not enough*. Co-authors: Melanie Schienle and Julia Schaumburg.
- **Cui, Qiurong**, *Multivariate Frechet tilted Gaussian distributions for modeling mixed positive/negative and asymptotic dependencies*. Co-author: Zhengjun Zhang.
- **Hanel, Martin**, *Scale-consistent assessment of trends in precipitation extremes in the Czech Republic*. Co-authors: Adam Vizina and Alena Pavlaskova.
- **Ma, Chunhua**, *Asymptotic properties of estimators in a stable Cox-Ingersoll-Ross model*. Co-author: Zenghu Li.
- **Tan, Zhongquan**, *The limit theorems for maxima of stationary Gaussian processes with random index*.
- **Wu, Yanyun**, *A spatio-directional splines model for extreme waves in the Gulf of Mexico*. Co-authors: Philip Jonathan and David Randell.
- **Yang, Yang**, *On extremal behaviour of aggregation of largest claims*.

Reception & Poster Session 18:00-20:00 (Crowne Plaza Hotel)

Tuesday, July 9, 2013

8:30-10:15 Session-3 (I5, I6)

**Invited Session-I5, Room 301**

Title: **EV -- Extremes and Vimeiro**  Organizer/Chair: Ivette Gomes
• Ross Leadbetter, Risks in applying limit theorems in Statistics, and Risks to vessels in stormy seas- revisitations.
• Jürg Hüsler, Frost data analysis after Vimeiro.
• Manuela Neves, Adaptive and computational procedures in extreme value parameter’s estimation.

**Invited session-I6, Room 302**

Title: **Extremal Modelling for Complex Data**  Organizer/Chair: Anthony Davison

- Daniel Cooley, Data mining for extreme behavior: investigating the causes of extreme ground-level ozone observations.
- Sebastian Engelke, Estimation of Brown-Resnick processes based on single extreme events.
- Jenny Wadsworth, Efficient inference for spatial extremes, and some thought beyond max-stability.

**10:15-10:45 Coffee/Tea Break (3rd floor)**

**10:45-12:25 Session-4 (C1, C2)**

**Contributed Session-C1, Room 301**

Title: **Tail Inferences**  Chair: Jingchen Liu

- M.-O. Boldi, Fitting models for high quantile: a direct approach.
- Michel Broniatowski, Exceedances of the sample mean for light tailed summands.
- Ivette Gomes, A mean of order p reduced-bias and location-invariant extreme value index estimator.
- Armelle Guillou, Robust conditional Weibull-type estimation.

**Contributed Session-C2, Room 302**

Title: **Extremes in Climate and T-copula**  Chair: Richard Davis

- Zhengjun Zhang, Examining tail dependence in large scale precipitation data across continental USA.
- Daniel Maposa, Investigating the goodness-of-fit of ten candidate distributions and estimating High Quantiles of extreme floods in the lower Limpopo River Basin, Mozambique.
- Martin Roth, Extreme precipitation in a changing climate: A regional POT approach.

**12:25-13:30 Lunch (9th floor)**

**14:00-15:40 Session-5 (C3, C4)**

**Contributed Session-C3, Room 301**

Title: **Tail Copula and Other Dependence**  Chair: Yongcheng Qi

- Lei Hua, Relations between hidden regular variation and tail order of copulas.
- Yuebao Wang, Some new dependence structures of random variables and its applications.
• Jingping Yang, *Pricing \( k^\text{th} \) realization derivatives with \( C^{A;B} \) Copula.*
• Stefan Aulbach, *Testing for a delta-neighborhood of a generalized Pareto copula.*

**Contributed Session-C4, Room 302**  
Title: **Modeling Extremes**  
Chair: Yizao Wang  
• Ping Li, *Efficient compressed sensing with \( L_0 \) stable random projections.*
• Qiurong Cui, *Multivariate Frechet tilted multivariate Gaussian distributions.*
• Maximilian Zott, *On generalized max-linear models.*

15:40-16:10 Coffee/Tea Break (3rd floor)

16:10-17:55 Session-6 (I7, I8)  

**Invited Session-I7, Room 301**  
Title: **Regular Variation and Dependence**  
Organizer: Claudia Klüppelberg  
Chair: Zhengjun Zhang  
• Vicky Fasen, *Spectral estimates for high-frequency sampled CARMA processes.*
• Thomas Mikosch, *On Jakubowski’s approach to limit theory for regularly varying sequences.*
• Paul Embrechts, *Risk aggregation under dependence scenarios.*

**Invited session-I8, Room 302**  
Title: **Generalized Pareto Process and Applications**  
Organizer: Ana Ferreira  
Chair: Ping Li  
• Michael Falk, *The functional D-norm revisited.*
• Clément Dombry, *Functional regular variations, Pareto processes and peaks over threshold.*
• Ana Ferreira, *The GP process and the peaks-over-threshold method.*

**Wednesday, July 10, 2013**

8:30-10:10 Session-7 (C5, C6)  

**Contributed Session-C5, Room 301**  
Title: **Asymptotics (1)**  
Chair: John Nolan  
• Zhansheng Cao, *A conditional limit theorem for random walks under extreme deviation.*
• Shouquan Chen, *Rates of convergence of extreme for general error distribution under power normalization.*
• Lei Sun, *Statistical methods for association studies of rare variants.*
• Jelena Jockovic, *Coupon collector’s problem and its extensions in extreme value framework.*

**Contributed Session-C6, Room 302**
Title: Asymptotics (2)  Chair: Nader Tajvidi

- Zhongyi Yuan, *Randomly weighted sums of subexponential random variables in insurance and finance.*
- Lanpeng Ji, *Piterbarg theorems for Chi-processes with trend.*
- Mofei Jia, *Asymptotic properties of the empirical structure function of heavy-tailed data and tail index estimation.*

10:10-10:40 Coffee/Tea Break (3rd floor)

10:40-12:20 Session-8 (C7, C8)

**Contributed Session-C7, Room 301**

Title: Max-stable Processes  Chair: Paul Embrechts

- Kirstin Strokorb, *All tail correlation functions are realized by max-stable processes.*

**Contributed Session-C8, Room 302**

Title: Extremes in Business  Chair: Vicky Fasen

- Abdelaati Daouia, *A gamma-moment approach to monotonic boundaries estimation: with applications in econometric and nuclear fields.*
- Tomaas Tichy, *Comparison of market risk models of different classes.*
- Jonas Alm, *Foreign-currency interest-rate swaps in asset-liability management: an application of extreme value statistics in insurance.*

12:20-13:20 Lunch (9th floor)

City Tour: 13:30-17:30

Conference Dinner 18:30-21:00

Thursday, July 11, 2013

8:30-10:15 Session-9 (I9, I10)

**Invited Session-I9, Room 301**

Title: Regression Analysis  Organizer/Chair: Armelle Guillou

• Stéphane Girard, *Nonparametric extremal quantile regression.*
• Valerie Chavez-Demoulin, *High dimensional financial extremes.*

**Invited Session-I10, Room 302**
Title: *Exceedances and Extrema of Random Fields*
Organizer: Gennady Samorodnitsky Chair: John Segers
• Yimin Xiao, *Geometry and excursion probability of multivariate Gaussian random fields.*
• Yi Shen, *Supremum location and stationarity.*
• Gennady Samorodnitsky, *On the existence of paths between points in high level excursion sets of Gaussian random fields.*

10:15-10:45 Coffee/Tea Break (3rd floor)

**10:45-12:25 Session-10 (C9, C10)**

**Contributed Session-C9, Room 301**
Title: *Tail inferences* Chair: Phillipe Naveau
• Laurens de Haan, *On the block maxima method in extreme value theory.*
• Toshikazu Kitano, *Standing at the edges on extrapolation to extremes with the degree of experience.*
• Laurent Gardes, *Estimation of the conditional tail index using a smoothed local Hill estimator.*
• Shuyan Liu, *Estimation of parameters of regularly varying distributions with an application on planetary perturbations on comets.*

**Contributed Session-C10, Room 302**
Title: *Extremes in Climate* Chair: Ana Ferreira
• Adam Vizina, *Drought propagation in the Czech Republic by resampling data with weather generators.*
• Emeric Thibaud, *Threshold modelling of spatial extremes.*
• Ross Towe, *Statistical downscaling of the extreme wave climate of the North Sea.*

12:25-13:30 Lunch (9th floor)

**14:00-15:40 Session-11 (C11, C12)**

**Contributed Session-C11, Room 301**
Title: *Risk Measures* Chair: Michael Falk
• Cees de Valk, *Toward a new approach to estimation of high quantiles.*
• Xiao Qin, *Systemic risk allocation for systems with small number of banks.*
• Jonathan El Methni, *Estimation of extreme risk Measures from heavy-tailed distributions.*
• Michael Osmann, *Kernel regression with Weibull-type tails.*
Contributed Session-C12, Room 302
Title: **Modeling Extremes**  Chair: Jenny Wadsworth
- Carl Scarrott, *Extreme value mixture models - An R package and simulation study.*
- Holger Rootzén, *Tail estimation for window-censored 0-1 processes.*

15:40-16:10 Coffee/Tea break (3rd floor)

16:10-17:55 Session-12 (I11, I12)

Invited Session-I11, Room 301
Title: **Multivariate Extremes Techniques**  Organizer/Chair: Dan Cooley
- John P. Nolan, *Dense classes of multivariate extreme value distributions.*
- Grant Weller, *A sum characterization of hidden regular variation with likelihood inference via the EM algorithm.*

Invited Session-I12, Room 302
Title: **Statistics of Multivariate Extremes**  Organizer: John Einmahl  Chair: Liang Peng
- Sami Umut Can, *Asymptotically distribution-free goodness-of-fit testing for tail copulas.*
- Juan-Juan Cai, *Estimation of extreme risk regions under multivariate regular variation.*
- John Einmahl, *Estimation of the marginal expected shortfall: the mean when a related variable is extreme.*

Friday, July 12, 2013

8:30-10:15 Session-13 (I13, I14)

Invited Session-I13, Room 301
Title: **Extremes of Gaussian Processes**  Organizer/Chair: Jürg Hüsler
- Jean Marc Azaïs, *Tail of the maxima of Gaussian processes defined on non locally convex sets.*
- Marie Kratz, *On the capacity functional of excursion sets of Gaussian random fields on \( \mathbb{R}^2 \).*
- Jingchen Liu, *Some asymptotic results of nonlinear functionals Gaussian random fields.*

Invited Session-I14, Room 302
Title: **Extremes of Rainfall, Floods, and Random Energy Systems**  Organizer/Chair: Holger Rootzén
- Phillipe Naveau, *Analysis of heavy rainfall in high dimensions.*
- Nader Tajvidi, *On estimation and prediction for bivariate extreme value distributions.*
- Anthony Davison, *Spectral density ratio models for multivariate extremes.*
10:15-10:45 Coffee/Tea Break (3rd floor)

10:45-12:25 Session-14 (C13, C14)

**Contributed Session-C13, Room 301**
Title: Asymptotics (3)  Chair: Chen Zhou
- Xin Liao, Tail behavior of the logarithmic skew normal distribution and its applications.
- Pavle Mladenovic, Limit theorems for maxima in bivariate stationary sequences.
- Hailin Sang, Exact moderate and large deviations for linear processes.
- Takaaki Shimura, Discretization of distributions in the maximum domain of attraction.

**Contributed Session-C14, Room 302**
Title: Asymptotics (4)  Chair: Yuri Goegebeur
- Chengxiu Ling, Second-order tail asymptotics of deflated risks.
- Takashi Owada, Functional limit theorem for partial maxima for stationary symmetric alpha-stable processes generated by conservative flows.
- Xuan Yang, On variance of quantiles of weighted sample.
- Zhiyun Gong, Asymptotic independence of sample means and extremes from a periodic time series.

12:30-14:00 Lunch (Guoding 365 Restaurant)

14:30-16:15 Session-15 (I15)

**Invited Session-I15, AIA Hall**
Title: Statistics of Extremes  Organizer/Chair: Laurens de Haan
- Deyuan Li, Estimation of extreme conditional quantiles through power transformation.
- Holger Drees, Extreme value methods for nonparametric regression models with irregular error distribution.
- Chen Zhou, Statistics of heteroscedastic extremes.

16:15-17:00 Coffee/Tea (1st floor)
Abstracts
Statistical Modelling of Price Commodities

Stephen Chan and Emmanuel Afuecheta (poster)
University of Manchester, UK
Email: stephen.chan@manchester.ac.uk and emmanuel.afuecheta@manchester.ac.uk

Saralees Nadarajah
University of Manchester, UK

Key words: Prices; Student’s t distribution; Commodities

Abstract

In this talk, we propose a model for price of commodities over the years [1998-2013]. The model is a mixture based on the Student’s t distribution. It describes the trajectory price movement of some commodities and gives a good fit to the data within the period under study. The parameters of the model are estimated by the method of maximum likelihood. The fitted models are used to make future predictions.
Foreign-currency interest-rate swaps in asset-liability management: an application of extreme value statistics in insurance

Jonas Alm (speaker)
Chalmers University of Technology, Gothenburg, Sweden
Email: jonasa@chalmers.se

Filip Lindskog
KTH Royal Institute of Technology, Stockholm, Sweden

Key words: Interest-rate swaps; Asset-liability management; Solvency capital requirements; Extreme-value statistics; Extreme scenarios

Abstract

We consider an insurer with purely domestic business whose liabilities towards its policy holders have long durations. The relative shortage of domestic government bonds with long maturities makes the insurer’s net asset value sensitive to fluctuations in the zero rates used for liability valuation. Therefore, in order to increase the duration of the insurer’s assets, it is common practice for insurers to take a position as the fixed-rate receiver in an interest-rate swap. We assume that this is not possible in the domestic currency but in a foreign currency supporting a larger market of interest-rate swaps. Monthly data over 16 years are used as the basis for investigating the risks to the future net asset value of the insurer from using foreign-currency interest-rate swaps as a proxy for domestic ones in asset-liability management. We find that although a suitable position in swaps may reduce the standard deviation of the future net asset value it may also significantly increase the tail heaviness, which has a substantial effect on the estimation of the solvency capital requirements.

References

GPA: Graphical Interface Based Path Coefficient Analysis

Muhammad Amin (poster)
Dalian University of Technology, China
Email: aminkanju@gmail.com

Wang Xiaoguang, Lixin Song, Muhammad Zubair
Dalian University of Technology, China

Jafar Hussain
Nuclear Institute for Agriculture and Biology, Pakistan

Tila Muhammad
Nuclear Institute for Food Agriculture, Pakistan

Key words: Graphical User Interface, computer program, regression, direct and indirect effect

Abstract

Graphical User Interface (GUI) allows common users to interact with electronic devices using visuals rather than a complicated text commands. To quantify the contribution of causal traits/variables with targeted effect variable directly and indirectly through other variables has always remained the coating that researchers rarely examine. This analysis method is an extension to regression analysis where researchers are able to quantitatively examine the direct contributions to the effect variable and the indirect effects through other variable to effect the variables. Sometimes researchers stop their investigation at the level of regression analysis, they could not try to find out any direct and indirect causes of the association due to lack of easily attractive computer programs of path coefficient analysis. The real data set of wheat crop is used to calculate the direct and indirect effects of yield and its associated traits. This GUI can be used as decision tool and provide help for researchers in determining the causal effects. The users are able to import their data easily from Microsoft Excel data sheets to save their time of data entering manually. With provision of some basic information about path coefficient analysis, GUI gives almost all the results in both graphical and tabular forms to the researchers. A common user of Microsoft windows operating system can easily run this program.
Testing for a \(\delta\)-neighborhood of a generalized Pareto copula

Stefan Aulbach (speaker)
University of Würzburg, Germany
Email: stefan.aulbach@uni-wuerzburg.de

Michael Falk
University of Würzburg, Germany

Key words: Multivariate max-domain of attraction; Multivariate extreme value distribution; Copula; Empirical copula; Generalized Pareto copula; \(D\)-norm; Sojourn time; Chi-square goodness-of-fit test; Max-stable processes; Functional max-domain of attraction

Abstract

A multivariate distribution function \(F\) is in the max-domain of attraction of an extreme value distribution if and only if this is true for the copula corresponding to \(F\) and its univariate margins. Aulbach et al. [1] have shown that a copula satisfies the extreme value condition if and only if the copula is tail equivalent to a generalized Pareto copula (GPC). In this paper we propose a \(\chi^2\)-goodness-of-fit test in arbitrary dimensions for testing whether a copula is in a certain neighborhood of a GPC.

The results carry over to function space as well, allowing to test whether the copula process of a stochastic process in \(C[0,1]\) is in a certain neighborhood of a generalized Pareto process.

References

Tail of the maxima of Gaussian processes defined on non locally convex sets

Jean-Marc Azaïs (speaker)
University of Toulouse, France
Email: jean-marc.azais@math.univ-toulouse.fr

Viet-Hung Pham
University of Toulouse, France

Key words: Gaussian fields, Steiner formula, distribution of the maximum.

Abstract

The classical Euler Characteristic method of [1] or the direct method of [2] provide an expansion of the tail of the maximum of a Gaussian field. This expansion is super-exponentially sharp but it is based on some regularity conditions of the parameter set including a local convexity condition. For example, a classical open problem is the case on the “angle” : to segments that are tied by one extremity. Using a methodology defined by Azaïs and Wschebor [3] we solve the problem of the angle and give some extra examples with rather unexpected results. A full expansion is given in dimension 2 for a very large class of parameter sets and some examples are given in higher dimension showing the difficulty to obtain a general formula in that case.

References

On the estimation of spatial max-stable processes using threshold exceedances

J. N. Bacro (speaker)
I3M, University of Montpellier II, France
Email: jean-noel.bacro@univ-montp2.fr

C. Gaetan
University Ca’ Foscari-Venice, Italy

T. Opitz
I3M, University of Montpellier II, France

Key words: Spatial max-stable processes; Threshold methods; Spectral measure; Spatial extremes;

Abstract

Parametric likelihood inference for spatial max-stable processes is often based on composite likelihood estimation: parameter estimates are obtained by fitting the model to block bivariate maxima vectors. In this talk we deal with estimation procedures based on a composite likelihood approach using exceedances over a high threshold. Three different estimating functions are considered ([1], [3]). The first one exploits a tail approximation for the bivariate distribution valid when both components exceed a large threshold ([2]) while the second one is based on the bivariate generalized Pareto distribution when at least one of the components is over the threshold ([4]). The third approach uses the spectral measure arising from radial threshold exceedances with respect to a pseudo-polar representation of bivariate tails ([3]). The different approaches are compared through a simulation study with respect to different spatial extremal dependencies. Max-stable processes as well as processes in their domain of attraction are considered and potential sources of bias are discussed.

References

Fitting models for high quantile: a direct approach

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Key words: GEV; non-stationarity; optimization; parameter of interest.

Abstract

We address an issue in the estimation of models for non-stationary time series of extreme values. To illustrate, let us consider a practitioner analyzing a non-stationary time series of maxima at times \( t = 1, \ldots, T \). A non-stationary GEV model is fitted. The classical parameterization, encompassing location, \( \mu_t \), scale, \( \sigma_t \), and shape, \( \kappa_t \), is not of interest. The parameterization of interest is the return level \( r_t \). The practitioner wants to test the slope of a linear model \( r_t = \alpha + \beta t \) with a likelihood ratio test. As the likelihood function is cumbersome to write, the maximum likelihood estimates of \( \alpha \) and \( \beta \) are obtained via a constrained optimization program. The likelihood function is expressed with the classical parameters \( \mu_t, \sigma_t \) and \( \kappa_t \), while they are linked to the parameters of interest \( \alpha \) and \( \beta \) by the constraints. The optimization is solved using an Uzawa algorithm. Finally, the inference is obtained directly on the interest parameters via a likelihood ratio test. Overall, this approach can be extended to more general models than a linear one, such as a semi-parametric model for \( r_t \) like in [1], other likelihoods, such as the GPD, and other functions of interest, such as the Value-at-Risk.

References

Decomposing multivariate tail risks: When tail correlations are not enough

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Keywords: stable tail dependence function; multivariate extremes; asymmetric tail risk contributions; risk management

Abstract

Dependencies of extreme cross-sectional asset movements are generally measured pairwisely by tail correlation (tc) based methods. We propose a flexible test which shows when tc fail to draw a full picture of multivariate extreme risks. In Extreme Value Theory, the stable tail dependence function (stdf) describes the complete dependence structure of a multivariate extreme value distribution. Our central idea is to decompose the stdf for dimension $2 < k < \infty$ into stdf’s for dimension two and stdf’s for higher dimensions. This allows to measure the extent to which bivariate connections contribute to multivariate tail risk. Thereby, we can test if such tc’s completely explain higher-dimensional tail dependencies. A variation of the test detects asymmetric tail risk contributions among equidimensional relations. We establish the asymptotic behavior of the test statistic exploiting the results of [1]. A simulation study shows the test performs well in finite samples. In several financial application settings, we show that a substantial amount of multivariate extreme risks cannot be captured by tc’s. Thus, accounting for those higher-dimensional extreme risks, can e.g. lead to notable improvements on existing portfolio allocation strategies.

References

Exceedances of the sample mean for light tailed summands

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Key words: extreme deviation; conditional limit theorem; Erdős-Rényi law; aggregate forming; extreme values

Abstract

It is well known that for a fixed number of independent identically distributed summands with light tail, large values of the sample mean are obtained only when all the summands take large values. This paper explores this property as the number of summands tends to infinity. It provides the order of magnitude of the sample mean for which all summands are in some interval containing this value and it also explores the width of this interval with respect to the distribution of the summands in their upper tail. These results are proved for summands with log-concave or nearly log concave densities. Making use of some extension of the Erdős-Rényi law of large numbers it explores the forming of aggregates in a sequence of i.i.d. random variables. As a by product the connection is established between large exceedances of the local slope of a random walk on growing bins and the theory of extreme order statistics. The case of the Weibull distribution quantifies these effects.

References

Estimation of extreme risk regions under multivariate regular variation

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Key words: Extremes; Level Set; Multivariate Quantile; Rare Event; Spectral Density

Abstract

When considering $d$ possibly dependent random variables one is often interested in extreme risk regions, with very small probability $p$. We consider risk regions of the form \{ $z \in \mathbb{R}^d : f(z) \leq \beta$ \}, where $f$ is the joint density and $\beta$ a small number. Such a region has the property that it consists of the less likely points and hence that its complement is as small as possible. Estimation of such an extreme risk region is difficult since it contains hardly any or no data. Using extreme value theory, we construct a natural estimator of an extreme risk region and prove a refined form of consistency, given a random sample of multivariate regularly varying random vectors. In a detailed simulation and comparison study the good performance of the procedure is demonstrated. We also apply our estimator to financial data.
Asymptotically Distribution-Free Goodness-of-Fit Testing for Tail Copulas

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Key words: Tail dependence; Tail copula; Goodness-of-Fit Testing; Asymptotically distribution-free; Monte Carlo simulations

Abstract

Let \((X_1, Y_1), \ldots, (X_n, Y_n)\) be an i.i.d. sample from a bivariate distribution function \(F\). The asymptotic joint distribution of the component-wise maxima \(\bigvee_{i=1}^n X_i\) and \(\bigvee_{i=1}^n Y_i\) is characterized by the marginal extreme value indices and the tail copula \(R\) associated with \(F\). The extreme value indices specify the asymptotic marginal distributions of the component-wise maxima, and the tail copula specifies the dependence structure. We propose a procedure for constructing asymptotically distribution-free goodness-of-fit tests for the tail copula \(R\). The procedure is based on a transformation of a suitable empirical process derived from a semi-parametric estimator of \(R\). The transformed empirical process converges weakly to a standard Wiener process, paving the way for a multitude of asymptotically distribution-free goodness-of-fit tests. We verify our results through Monte Carlo simulations, which also show good power properties.
A conditional limit theorem for random walks under extreme deviation

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Key words: Extreme deviations; Gibbs conditional principle; tauberian theorem

Abstract

This paper explores a conditional Gibbs theorem for a random walk induced by i.i.d. \((X_1, \ldots, X_n)\) conditioned on an extreme deviation of its sum \((S^n_1 = na_n)\) or \((S^n_1 > na_n)\) where \(a_n \to \infty\). It is proved that when the summands have light tails with some additional regularity property, then the asymptotic conditional distribution of \(X_1\) can be approximated in variation norm by the tilted distribution at point \(a_n\), extending therefore the classical LDP case.

References

High dimensional financial extremes

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Key words: Extremes of finance; Factor model; High dimension; Max-stable model

Abstract

High dimensional financial time series exhibit joint extremes that can give serious financial losses, and have therefore received important consideration in the recent literature ([1]). In this paper we consider how such extremes might be modelled and how inference for them may be conducted. We first construct a model for the joint extremes of daily negative log-returns of simultaneous time series by considering a max-stable process for the upper tail of the underlying distribution. The model is an extremal t copula, which is the limiting copula of the most-used t copula for multivariate financial series [2]. We estimate its parameters using a factor model based on a constrained composite likelihood with number k of factors that we expect to be much smaller than the number D of simultaneous time series. The same approach for the inverted max-stable model is also considered ([3]). Discriminating between the max-stable factor model and its inverted counterpart provides insight about the asymptotic dependence or independence of extreme asset log-returns. Simulations indicate that the approach can perform well. An application is considered.

References

Rates of convergence of extreme for general error distribution under power normalization

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Key words: P-max stable laws; General error distribution; Maximum; Uniform convergence rate.

Abstract

By using the theory of p-max stable laws, we study the rates of convergence of extremes for general error distribution under power normalization. We derived the exact uniform convergence rate of the distribution of maximum to its extreme value limit.

References

Data Mining for Extreme Behavior: Investigating the Causes of Extreme Ground-Level Ozone Observations

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Key words: Extremal Dependence, Multivariate Regular Variation; Generalized Linear Models; Air Pollution

Abstract

It is well known that high air temperature is associated with high levels of ground level ozone. However, air temperature alone does not completely explain the most extreme levels of the air pollutant. The goal of this research is to identify the combination of meteorological covariates that is most strongly associated with extreme ozone levels. The method we propose relies on the framework of bivariate regular variation and specifically aims to optimize a metric associated with tail dependence. We suggest a data mining approach to find the combination of meteorological covariates that has the strongest tail dependence with ozone. Model selection is performed via cross-validation. A simulation study will be presented in addition to a discussion of preliminary results from an Atlanta, Georgia data set.
Multivariate Fréchet Tilted Gaussian Distributions for Modeling Mixed Positive/Negative and Asymptotic Dependencies

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Key words: Linear dependence, nonlinear dependence, asymmetric dependence, asymptotic dependence, copula functions.

Abstract

Complex data can simultaneously display asymmetric dependence, asymptotic dependence, and positive (negative) dependence between random variables under concern. Multivariate normal distributions and many other extant distributions are not capable of modeling all of those dependences simultaneously. This paper proposes a global parametric model that possesses the above mentioned variable dependence features by tilting multivariate normal distributions. The random variables (after marginally transformed to Fréchet scales) are decomposed into max linear functions of underlying Fréchet risks among which some are transformed from Gaussian copula and others are independent. Various dependence structures are created by allowing the random variables to share underlying (latent) risks with random impact parameters. This inspires various families of interesting distributions and introduces a new way of mixing and tilting distributions. We use multivariate extreme value theory and the maximum likelihood procedure in the tail region to estimate impact parameters of the latent risks. The global data is then used for estimating the multivariate normal correlation coefficients. The estimates are shown to be consistent. Bootstrap method is used to obtain estimated standard errors. The estimation scheme is illustrated on several sets of simulated data and also real data.

References

A Γ-moment approach to monotonic boundaries estimation: with applications in econometric and nuclear fields

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Key words: Edge data; Extreme-value index; Fracture toughness; Free disposal hull; Γ-moment; Minimum cost; Monotonicity.

Abstract

The estimation of optimal support boundaries under the monotonicity constraint is relatively unexplored and still in full development (see e.g. [1]). This article examines a new extreme-value based model which provides a valid alternative for completely envelopment frontier models that often suffer from lack of precision, and for purely stochastic ones that are known to be sensitive to model misspecification (see e.g. [2] for a nice survey). We provide unrelated motivating applications including the estimation of the minimal cost in production activity and the assessment of the reliability of nuclear reactors.

References

Abstract

A semiparametric estimation procedure based on a closed form expression of the extremogram is used to estimate the parameters in a max-stable space-time process. The asymptotic properties of the resulting parameter estimates are established and bootstrap procedures are then used to obtain asymptotically correct confidence intervals. A simulation study shows that the proposed procedure works well for moderate sample sizes. Finally, we apply this estimation procedure to the fitting a max-stable model to radar rainfall measurements in a region in Florida. This modeling procedure helps to quantify the extremal properties of the space-time observations.
Spectral density ratio models for multivariate extremes

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Key words:

Abstract

In this talk I shall describe an approach to regression analysis for inference on several samples of multivariate extremes, in which a parametric model for the effects of covariates is combined with a nonparametric model for the extremal distribution. The fitted model satisfies the usual mean constraints for the extremal distributions. The parameter estimators are asymptotically Gaussian and the usual chi-squared distributions apply for likelihood ratio statistics. The ideas are applied to data on forest temperatures. The work is joint with Miguel de Carvalho.
Functional regular variations, Pareto processes and peaks over threshold

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Key words: functional regular variations, generalized Pareto process, Peaks Over Threshold

Abstract

The last decades have seen many developments on max-stable processes and more recently on exceedances of stochastic processes. Paralleling the univariate extreme value theory, this work focuses on threshold exceedances of a stochastic process and their connections with regularly varying and generalized Pareto processes. More precisely we define an exceedance through a cost functional $\ell$ and show that the limiting (rescaled) distribution is a simple $\ell$–Pareto process whose spectral measure can be characterized. Several equivalent constructions for $\ell$–Pareto processes are given using either a constructive approach, either an homogeneity property or a peak over threshold stability. We also provide an estimator of the spectral measure and give some examples.
Extreme value methods for nonparametric regression models with irregular error distribution

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Key words: nonparametric regression, irregular error distribution, uniform rate of convergence

Abstract

We consider a nonparametric regression model

$$Y_i = g(X_i) + \varepsilon_i, \quad 1 \leq i \leq n,$$

where $g$ is an unknown smooth function and the errors $\varepsilon_i$ are iid with cdf

$$F(y) = 1 - c|y|^\alpha + o(|y|^\alpha) \quad \text{as } y \uparrow 0$$

for some $\alpha < 2$. In this setting the unknown regression function $g$, which is assumed smooth, is defined as the right endpoint of the conditional distribution of $Y$ given $X$.

While in the usual mean value regression with regular error distribution the regression function $g(x)$ is estimated by local averages of the observations $Y_i$ with $X_i$ belonging to a neighborhood of $x$, in the irregular model considered here local maxima or more refined local extreme value estimators are used to construct estimators of $g$ which converge at a faster rate. We will present recent results about the uniform convergence of such regression estimators and applications to testing problems.
Estimation of the Marginal Expected Shortfall: the mean when a related variable is extreme

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Key words: Asymptotic normality; Conditional tail expectation; Extreme values.

Abstract

Denote the loss return on the equity of a financial institution as $X$ and that of the entire market as $Y$. For a given very small value of $p > 0$, the Marginal Expected Shortfall (MES) is defined as $E(X \mid Y > Q_Y(1 - p))$, where $Q_Y(1 - p)$ is the $(1 - p)$-th quantile of the distribution of $Y$. The MES is an important factor when measuring the systemic risk of financial institutions. For a wide nonparametric class of bivariate distributions, we construct an estimator of the MES and establish the asymptotic normality of the estimator when $p \downarrow 0$, as the sample size $n \to \infty$. Since we are in particular interested in the case $p = O(1/n)$, we use extreme value techniques for deriving the estimator and its asymptotic behavior. The finite sample performance of the estimator and the adequacy of the limit theorem are shown in a detailed simulation study. We also apply our method to estimate the MES of three large U.S. investment banks.
Estimation of Extreme Risk Measures from Heavy-tailed distributions

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Key words: Conditional tail expectation, heavy-tailed distributions, kernel estimator, risk measures, conditional quantiles.

Abstract

Value-at-risk, conditional tail expectation [1], conditional value-at-risk [4] and conditional tail variance [5] are classical risk measures. In statistical terms, the value-at-risk is the upper \( \alpha \)-quantile of the loss distribution where \( \alpha \in (0,1) \) is the confidence level. Here, we focus on the properties of these risk measures for extreme losses (where \( \alpha \to 0 \) is no longer fixed). To assign probabilities to extreme losses it is assumed that we are in the case of heavy-tailed distributions. We also consider these risk measures in the presence of a covariate. Let us note that the presence of a covariate has already been investigated in extreme value theory, see for instance [2,3].

The main goal of this communication is to propose estimators of the above risk measures in the case of heavy-tailed distributions, for extreme losses, and to include a covariate in the estimation. The asymptotic distribution of our estimators is established and their finite sample behavior is illustrated on simulated data and on a real data set of pluviometrical measurements.

References

Risk Aggregation under Dependence Scenarios

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Key words:

Abstract

Often questions concerning risk aggregation for banking and insurance (under Basel II or Solvency 2) involves considerable model uncertainty. Whereas some statistical information on the marginal risks may be assumed, much less information on the interdependence of these risks is available. In this talk I will discuss the construction of sharp inf-sup bounds on the Value-at-Risk (i.e. a high quantile measure) of the sum of d risks and discuss a so-called rearrangement algorithm for the numerical calculation of these bounds. I will also give information on the best (inf) and worst (sup) dependence scenarios (couplings) leading to these bounds.

References

Estimation of Brown-Resnick processes
based on single extreme events

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Key words: Brown-Resnick process; extreme value statistics; Hüsler-Reiss distribution; peaks-over-threshold

Abstract

Brown-Resnick processes are a flexible class of max-stable processes that constitute a competitive model in spatial extreme value statistics [2]. Statistical inference is however difficult since the densities of their multivariate margins, namely the Hüsler-Reiss distributions, do not admit a closed expression. The composite likelihood approach is widely applied to avoid this problem. It uses only bivariate distributions and assumes that pairs of locations are independent of each other. In this talk we will present a different technique that is based on observations in the max-domain of attraction of a Brown-Resnick process that exceed a high threshold at one location (cf. [1]). The asymptotic distribution of increments of these exceedances turns out to be a multivariate normal distribution and this enables a new method of estimating the parameters of the limiting Brown-Resnick process. In particular, full multivariate (and not only bivariate) densities can be used for maximum likelihood. For instance, this additional information better captures the shape of the variogram that parameterizes the dependence structure of the Brown-Resnick process. The technique is applied to model extreme wind speed in the Netherlands.

References

The Functional $D$-Norm Revisited

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Key words: Max-stable process; $D$-norm; survivor function; generalized Pareto process; $\delta$-neighborhood of generalized Pareto process; rate of convergence

Abstract

Aulbach et al. (2012) introduced some mathematical framework for extreme value theory in the space of continuous functions on compact intervals. Continuous max-stable processes on $[0, 1]$ were characterized by their functional distribution function, which can be represented via a norm on function space, called $D$-norm. We introduce certain $\delta$-neighborhoods of generalized Pareto processes, which can be characterized by their rate of convergence towards a max-stable process. This is in complete accordance with the multivariate case.

References

Spectral Estimates for High-Frequency Sampled CARMA Processes

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Key words: CARMA process; consistency; high-frequency data; Lévy process; parameter estimation; periodogram; power transfer function; smoothed periodogram; spectral estimation

Abstract

In this talk we consider a continuous-time autoregressive moving average (CARMA) process driven by either a symmetric $\alpha$-stable Lévy process with $\alpha \in (0, 2)$ or a symmetric Lévy process with finite second moments. In the asymptotic framework of high-frequency data within a long time interval, we establish a consistent estimate for the normalized power transfer function by applying a smoothing filter to the periodogram of the CARMA process. We use this result to propose an estimator for the parameters of the CARMA process and exemplify the estimation procedure by a simulation study.

References

The GP process and the peaks-over-threshold method

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Key words: Generalized Pareto process; Peaks-over-threshold; Simulation of extreme events

Abstract

We discuss the generalized Pareto (GP) process, i.e. the infinite dimensional version in the space of continuous functions of generalized Pareto random variables and vectors.
In statistics of extremes, the peaks-over-threshold method relies in a stability property of the Pareto distributions and indicates that inference is mainly based on the highest observations. We also discuss the method in our framework. Moreover our approach justifies a scheme for simulating very extreme observations of continuous stochastic processes with a probability distribution in the domain of attraction of some max-stable process.
Estimation of the conditional tail index using a smoothed local Hill estimator

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Key words: Heavy-tailed distribution; Random covariate; Uniform consistency; Pointwise asymptotic normality

Abstract

For heavy-tailed distributions, the so-called tail-index is an important parameter that controls the behavior of the tail distribution and is thus of primary interest to estimate extreme quantiles. In this paper, the estimation of the tail index is considered in the presence of a finite-dimensional random covariate. More precisely, we adapt Hill’s estimator [2] to our situation and we establish uniform weak consistency and asymptotic normality of the proposed estimator. Note that in most papers dedicated to the estimation of the tail-index in presence of a covariate (see for instance [1,3]), only pointwise weak consistency is established. We also provide some illustrations on simulations.

References

Nonparametric extremal quantile regression

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Key words: Regression, extreme quantile, extreme-value index, kernel smoothing, von-Mises condition, asymptotic normality

Abstract

Nonparametric regression quantiles obtained by inverting a kernel estimator of the conditional distribution of the response are long established in statistics [1,3,4]. Attention has been, however, restricted to ordinary quantiles staying away from the tails of the conditional distribution. The purpose of this paper is to extend their asymptotic theory into the tails. We focus on extremal quantile regression estimators of a response variable given a vector of covariates in the general setting, whether the conditional extreme-value index is positive, negative, or zero. Their limit distribution is established when they are located in the range of the data or near and even beyond the sample boundary, under technical conditions that link the speed of convergence of their order with the oscillations of the quantile function and a von-Mises property of the conditional distribution [2]. A simulation experiment and an illustration on American electric data are presented.

References

Local robust and asymptotically unbiased estimation of conditional Pareto-type tails

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Key words: Pareto-type distribution; tail index; bias-correction; density power divergence; local estimation

Abstract

We introduce a nonparametric robust and asymptotically unbiased estimator for the tail index of a conditional Pareto-type response distribution in presence of random covariates. The estimator is obtained from local fits of the extended Pareto distribution to the relative excesses over a high threshold using an adjusted minimum density power divergence estimation technique. We derive the asymptotic properties of the proposed estimator under some mild regularity conditions, and also investigate its finite sample performance with a small simulation experiment. It is illustrated that the estimator has nice robustness properties when contamination is present.

References

Spatial modeling of extremes: a case study of extreme precipitation

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Key words: Extreme Dependence; Geostatistics; Max-Stable processes; R Software; Spatial Extremes.

Abstract

Natural hazards such as high rainfall and windstorms, arise due to physical processes and are spatial in extent. Spatial statistics deals with statistical methods in which spatial locations play an explicit role. Classical geostatistics is mostly based on multivariate normal distributions, inappropriate for modeling tail behavior. Spatial extreme analysis joins two areas of statistics: extreme value analysis and geostatistics. A variety of statistical tools have been used for the spatial modeling of extremes, including Bayesian hierarchical models, copulas and max-stable random fields. Max-stable processes form a natural class of processes extending extreme value theory when sample maxima are observed at each site of a spatial process. Recent developments of extremal spatial approaches are here reviewed. A real case of extreme spatial precipitation in Portugal is discussed. This study also intends to show the main tools for the statistical analysis in spatial extremes using R software. New functions were also defined. Maps of extreme precipitation from the fitted max-stable models are also obtained.
A mean of order $p$ reduced-bias and location-invariant extreme value index estimator

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Key words: Bias estimation; Bootstrap methodology; Heavy tails; Semi-parametric reduced-bias estimation; Statistics of extremes

Abstract

We are interested in reduced-bias versions of a simple generalisation of the classical Hill estimator of a positive extreme value index (EVI), the primary parameter of extreme events. Indeed, given a random sample, $X_1, \ldots, X_n$, with associated ascending order statistics $X_{1:n} \leq \cdots \leq X_{n:n}$, the Hill estimator (Hill, 1975) can be regarded as the logarithm of the geometric mean of $U_{ik} := X_{n-i+1:n}/X_{n-k:n}$, $1 \leq i \leq k < n$. Instead of such a geometric mean, we can more generally consider the mean of order $p \geq 0$ (MOP) of those statistics. The asymptotic behaviour of the class of MOP EVI-estimators, detailed in Brilhante et al. (2013) for values of $p < 1/\gamma$, is reviewed, and associated reduced-bias MOP (RBMOP) and optimal RBMOP (ORBMOP) classes of EVI-estimators are suggested and studied both asymptotically and for finite samples. With PORT standing for peaks over random threshold, a terminology coined in Araújo Santos et al. (2006), we further advance with a PORT-RBMOP EVI-estimator, dependent on an extra tuning parameter $q \in [0, 1)$. An adequate choice of the tuning parameters under play is put forward, and an application to simulated and real data is performed.

References

ASYMPTOTIC INDEPENDENCE OF SAMPLE MEANS AND EXTREMES FROM A PERIODIC TIME SERIES

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Key words: Periodic ARMA Model; Maximum; Asymptotic Independence; Regenerative Process; Lévy Process

Abstract

In this paper, the asymptotic independence between sample means and maxima from a periodic time series is derived. Our setup entails a causal periodic autoregressive moving-average model with IID periodic noise with a finite $(2 + \delta)$-moment. Our approach takes a regenerative process setup, truncating to reduce the issues to a periodic moving-average model. Convergence to a Lévy process of form $\sigma B(t) + J(t)$ is shown, where the means and maxima are respectively obtained from these two independent components. Here, the Brownian motion is $\{B(t)\}$ and the jump process is $\{J(t)\}$.

References

Robust conditional Weibull-type estimation

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Key words: Weibull-type distribution; density power divergence; local estimation

Abstract

In this talk, we study nonparametric robust tail index estimation when the variable of interest, assumed to be Weibull-type, is observed simultaneously with a random covariate. In particular, we introduce a robust estimator for the tail index, using the idea of the density power divergence (see Basu et al., 1998) based on the relative excesses above a high threshold. The main asymptotic properties of our estimator are established under very general assumptions. The finite sample performance of the proposed procedure is evaluated by a small simulation experiment.

References

On the block maxima method in extreme value theory

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Key words: Block maxima

Abstract

The peaks-over-threshold method in extreme value theory is subject of much research. In contrast the block maxima method, that is also widely used, is not much considered in research. We formulate conditions under which the block maxima method for extremes is justified.
Scale-consistent assessment of trends in precipitation extremes in the Czech Republic

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Key words: Precipitation extremes; Regional frequency analysis; Climate change

Abstract

Detection of systematic changes in precipitation extremes is difficult due to large year to year variability. The effects of natural variability can be reduced using spatial pooling of data from neighbouring stations over certain (homogeneous) region. Still, if the records are short, the sites are strongly dependent or only few stations are available, the estimates of the characteristics of precipitation extremes might be not very accurate. In present study, a non-stationary index-flood model is applied to assess the trends in 30 min to 25 days precipitation maxima from 54 stations in the Czech Republic. It is assumed that the precipitation maxima at each station follow a Generalized Extreme value distribution with parameters dependent on the global average temperature anomaly. In addition, we assume that the changes in the GEV parameters vary smoothly across time aggregations. It is shown, that this assumption leads to reduction of standard errors of the estimates. The preliminary results indicate increasing trends in the GEV location parameter and for aggregation longer than 10 hours also for the dispersion coefficient. However, for short aggregation times the trend in the dispersion coefficient is negative. Interestingly, this is in accordance with the findings from regional climate models which have been assessed for the area.
Frost data analysis after Vimeiro

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Key words: Frost data; Crossing probabilities; Non-constant boundary

Abstract

Thirty years ago we talked at the Vimeiro conference on frost data analysis and statistical applications. This is related to crossing probabilities of stochastic processes with a certain trend above a given threshold. The considered stochastic process had discrete time points. We discuss the development of new results related to such problems, including processes with continuous time and more general boundaries or trends.

References

Relations between hidden regular variation and tail order of copulas

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Key words: Multivariate regular variation; tail dependence; upper exponent function; tail order function; intermediate tail dependence

Abstract

We study the relations between tail order of copulas and hidden regular variation (HRV) on subcones generated by order statistics. Multivariate regular variation (MRV) and HRV deal with extremal dependence of random vectors with Pareto-like univariate margins. Alternatively, if one uses copula to model the dependence structure of a random vector, then upper exponent and tail order functions can be used to capture the extremal dependence structure. After defining upper exponent functions on a series of subcones, we establish the relation between tail order of a copula and tail indexes for MRV and HRV. We show that upper exponent functions of a copula and intensity measures of MRV/HRV can be represented by each other, and thanks to Mitra and Resnick (2011) [1], the upper exponent function on subcones can be expressed by a Pickands-type integral representation. Finally, a mixture model is given with the mixing random vector leading to the finite directional measure in a product-measure representation of HRV intensity measures.

References

Refined analysis of asymptotically independent time series models

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Key words: coefficient of tail dependence; hidden regular variation; multivariate regular variation; stochastic volatility models; time series

Abstract

Most models for financial time series share the feature of regularly varying marginal distributions in order to reflect the heavy-tailed behavior of log-returns which is commonly accepted as a stylized fact. However, models differ with respect to their joint extremal behavior. Some models for stationary time series \((X_t)_t\) (like GARCH\((p,q)\) models) show asymptotic dependence, meaning that all pairs \((X_t, X_{t+h}), h \in \mathbb{Z}\), satisfy \(\lim_{x \to \infty} P(|X_{t+h}| > x \mid |X_t| > x) > 0\). Those models are well described by multivariate regular variation which gives an exhaustive description of the extremal behavior of the complete process.

On the other hand, there exist time series models which show asymptotic independence, i.e. \(\lim_{x \to \infty} P(|X_{t+h}| > x \mid |X_t| > x) = 0\) for all lags \(h \neq 0\). Stochastic volatility models are an example for this class. Both types of models have their raison d’être, in particular because they may share a quite similar finite sample behavior. But in this case the theory of multivariate regular variation gives us only trivial limit relations for the joint extremal behavior of the process. For finite dimensional asymptotically independent vectors, refined methods of extremal analysis have been developed in form of hidden regular variation (for vectors of arbitrary but finite dimension) and the coefficient of tail dependence (for 2-dimensional vectors). We discuss possible extensions of those concepts which allow us to describe the extremal behavior of the whole time series.

As an example we take a closer look at an extension of classic stochastic volatility models which allows for a flexible modeling of an asymptotically independent but non-trivial tail behavior.
Piterbarg Theorems for Chi-processes with Trend

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Key words: Gaussian random fields; Piterbarg theorems for chi-processes; Pickands constant; generalized Piterbarg constant; Piterbarg inequality

Abstract

Let $\chi_n(t) = (\sum_{i=1}^n X_i^2(t))^{1/2}$, $t \geq 0$ be a chi-process with $n$ degrees of freedom where $X_i$’s are independent copies of some generic centered Gaussian process. This paper derives the exact asymptotic behavior of

$$\mathbb{P}(\sup_{t \in [0,T]} \chi_n(t) - ct^\beta > u) \quad \text{as} \quad u \to \infty,$$

where $\beta, c, T$ are given positive constants. The case $c = 0$ is investigated in numerous deep contributions by V.I. Piterbarg. Our novel asymptotic results, for both stationary and non-stationary generic Gaussian processes, are referred to as Piterbarg theorems for chi-processes with trend.

References

Asymptotic Properties of the Empirical Structure Function of Heavy-tailed Data and Tail Index Estimation

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Key words: Empirical structure function; Heavy-tailed distributions; Scaling function; Regular variation

Abstract

The structure function and the scaling function which are usually employed for the analysis of multifractality do show peculiar behaviors when data with heavy tails are present, even if these are identically independent distributed and with tail index $\alpha > 2$ (Heyde 2009 & Sly 2005). This fact can be exploited for tail estimation and to question the presence of multifractality in some instances. In this paper, asymptotic properties of the empirical structure function are investigated for a large range of $\alpha$ and for dependent data as well. Based on these properties, we develop a new method to detect heavy tails and identify whether the $\alpha$ is larger than 2 or not, i.e., whether the variance exists or not. Estimators of $\alpha$ can also be obtained by regression. To test the performance of the proposed methods, we conduct various simulations and compare our estimators with the Hill estimator. The results show that our estimation method works better especially when 1) the true value of $\alpha$ is larger than 2 and 2) data are dependent. It is worth to mention that the financial returns process of risky assets often exhibit these two aforementioned notable properties.

References

Coupon collector’s problem and its extensions in extreme value framework

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Key words: Coupon collector’s problem; Limit theorems; Extreme value distributions; Generalized Pareto distributions

Abstract

Changing the stopping criterion in coupon collector’s problem leads to different extensions of the classical case, with various underlying distributions of the waiting times. Obtaining limit theorems in these cases may involve a number of technical difficulties. We give new results related to the asymptotic behavior of some of these waiting times and discuss certain problems related to this subject.

References

Standing at the edges on extrapolation to extremes with the degree of experience

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Key words: occurrence rate; leverage; weakly nonstationary model

Abstract

How far should the quantile curve fitted to the observed data be extended for the extrapolation? Is it possible to estimate the return level $y_R$ for the longest return period $R$ of our interest? Our discussion is concerned with the sample size available for our extreme value analysis of the real world’s problems arising in coastal engineering, hydrology, climate science and so on. The degree of experience $K$ is proposed as the following:

$$\frac{1}{K} = V(\log \lambda(y_R; \hat{\theta})) \quad \text{where} \quad \frac{1}{R} = \lambda(y_R; \theta) \quad \text{satisfies}.$$  

$K$ is an index to indicate the effective number against the actual sample size to be contributed to the estimation for the target occurrence rate $\lambda$ exceeding the level $y_R$ with the parameters $\theta = \{\mu, \sigma, \xi\}$ of generalized extreme value distribution (GEV). The criterion for the limitation of estimation/prediction is that $K \geq 2.0$, after the proverbs: What happened twice will happen three times, and others mentioned similarly. The degree of experience should be shown to be related to the leverage and the Cook's distance, which are often used in the regression analysis (Cook and Weisberg, 1982). Especially by including the time as a covariance (e.g. $\mu = \mu_0 + \beta_\mu t$), we can examine the limitation of another extrapolation, in other words, the applicability of the stationary model along the elapsed time from the observation with the time-dependent degree of experience. Consequently, the result can be obtained in the form of a constant point estimation of return level $\hat{y}_R$ with the confidence interval $(\hat{y}_L, \hat{y}_U)$ gradually enlarged with the time progressing, which could be called as a weakly nonstationary model.

References

Estimation of max-stable processes by simulated maximum likelihood

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Key words: Extreme value theory; Max-stable random fields; Nonparametric maximum simulated likelihood estimator; Spatial extremes; Spatial dependence

Abstract

Max-stable processes are very appropriate for the statistical modeling of spatial extremes. Nevertheless their inference is tedious. Indeed the multivariate density function is not available and thus standard likelihood-based estimation methods cannot be applied. The commonly used method - based on composite likelihood - leads to non efficient estimators. In this study an approach based on nonparametric simulated maximum likelihood is developed. The multivariate density (in space) is approximated by kernel methods. Our approach can be applied for many subclasses of max-stable processes and can provide better results than methods already introduced in the literature. This is true in particular when only a few temporal observations of the process are available and when the spatial dependence is high. The estimator is efficient when both the temporal dimension and the number of simulations tend to infinity. The methodology is examined on simulated data and applied to real data.

References

On the capacity functional of excursion sets of Gaussian random fields on $\mathbb{R}^2$

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Key words:

Abstract

In this work, we are interested in studying the capacity functional of excursion sets of Gaussian random fields on $\mathbb{R}^2$, as well as moment measures of some random measures which are induced by those sets. Often it is too complicated to describe the capacity functional completely. Therefore one usually restricts the family of sets to certain parametric families of sets. Here we do so, considering families of sets which consist of two or more linear segments, originating from a common point. Borrowing tools from the literature on level crossings and stochastic geometry, we study the capacity functional of such sets, which may also be seen as an approximation of the capacity functional of the excursion set for classes of convex polygons. Our methods allow also to obtain some results for the second moment measure of the boundary length measure of the excursion set, provided that the boundary is smooth enough.

References

Estimation of limiting conditional distributions for heavy tailed dependent sequences

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Key words: extremes; regular variation; time series; tail process

Abstract

We consider observations from a stationary regularly varying sequence and we are interested in estimating conditional laws given that some observations are large. Our approach is based on newly introduced tail and spectral processes (Basrak and Segers). Central limit theorems for weakly dependent time series (GARCH, ARMA) as well as non-central limit theorem for long memory stochastic volatility models are proven. We apply our results, in particular, to test asymptotic independence in the time series. We compare our approach with extremogram (Davis and Mikosch), tail dependence coefficient (Ledford and Tawn) and extremal dependence measure (Resnick).

References

Risks in applying limit theorems in Statistics, and Risks to vessels in stormy seas- revisitations

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Abstract

This talk is offered: (i) as a reminder of the need for general caution against the misuse of limit theorems in Statistics (exemplified in the context of Central Limit and Extreme Value Theory) and (ii) to revisit and update alternative risk analysis in the specific motivating problem of capsize of vessels at sea.

Statistics is replete with procedures based on limit theorems which are applied without full consideration of their validity - perhaps the most obvious example being the universal use of maximum likelihood. There is some justification for this since there are common well known conditions for valid application and it seems at least intuitively likely that such procedures are either somewhat robust, or at least are better than doing nothing. But clearly at least occasional thought should be given to underlying assumptions for procedures and models used.

We first briefly recall perceptive cautions expressed by LeCam regarding maximum likelihood estimation and then illustrate the hazards of less than careful consideration of appropriate conditions in the application of the Extremal Type-

s Theorem with reference to naval studies vessel capsize. Next we make the case that simulation is the "gold standard" for such risk evaluation, but that in low risk (but nonetheless interesting) cases the amount of simulation required can be prohibitive, even with modern computing facilities, briefly indicating the application of standard binomial methodology involved.

Our primary purpose is to revisit and update the development of alternative risk assessment for stability of vessels based partly on more theoretical modeling of the ocean as a Gaussian field, and its potential hazard to a vessel from more limited simulations indicating the geometry of "dangerous waves". This methodology involves Poisson Regression techniques and is validated by comparison with simulation estimates of risk where the latter are available. The results are part of a continuing collaboration with K. Stambaugh of the US Coastguard.
Modelling Non-stationary Extremes and Threshold Uncertainty

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Key words: non-stationary extremes; threshold uncertainty; mixture model; preprocessing

Abstract

Non-stationary extremes can be modelled by either a standard approach, which incorporates the covariates directly into the parameters of an extremes model, or a preprocessing approach, which aims to obtain a stationary series before fitting stationary extremes model. One thing that both approaches have in common is that they require specification of a suitably high threshold in order to define the extremes. To quantify threshold uncertainty, a popular approach is to use a mixture model, treating the threshold \( u \) as a parameter. One distribution is assumed below the threshold and the standard extremes model used above the threshold. In order to model non-stationary extremes and quantify threshold uncertainty simultaneously, a model combining the preprocessing approach and the mixture model is proposed. This enables inference to be drawn on the preprocessing parameters, the parameters in the extremes model and the threshold simultaneously. A simulation study is carried out to assess the performance of the model, before applying to a dataset of wave heights, where we want to separate the non-stationary tidal component from the weather generated extremes.
Estimation of Extreme Conditional Quantiles Through Power Transformation

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Key words: Box-Cox Power Transformation; Extreme Value; Heavy-tailed Distribution; High Quantile; Quantile Regression

Abstract

The estimation of extreme conditional quantiles is an important issue in numerous disciplines. Quantile regression provides a natural way to capture the covariates effects at different tails of the response distribution. However, without any distributional assumptions, estimation from conventional quantile regression is often unstable at tails especially for heavy-tailed distributions due to data sparsity. In this paper, we develop a new three-stage estimation procedure that integrates quantile regression and extreme value theory by estimating intermediate conditional quantiles using quantile regression and extrapolating these estimates to tails based on extreme value theory. Using the power-transformed quantile regression, the proposed method allows more flexibility than existing methods that rely on the linearity of quantiles on the original scale, while extending the applicability of parametric models to borrow information across covariates without resorting to nonparametric smoothing. In addition, we propose a test procedure to assess the commonality of extreme value index, which could be useful for obtaining more efficient estimation by sharing information across covariates. We establish the asymptotic properties of the proposed method and demonstrate its value through simulation study and the analysis of a medical cost data.

References

Efficient Compressed Sensing with L0 Stable Random Projections

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Key words: Compressed Sensing; Exact Sparse Recovery; Stable Distributions; Random Projections

Abstract

Many applications concern sparse signals, for example, detecting anomalies from the differences between consecutive images taken by surveillance cameras. In general, anomaly events are sparse. This talk focuses on the problem of recovering a K-sparse signal in N dimensions (coordinates). Classical theories in compressed sensing say the required number of measurement is $M = O(K \log N)$. In our most recent work on L0 projections (using $\alpha$-stable random projections with $\alpha \approx 0$), we show that an idealized algorithm needs about $M = 5K$ measurements, regardless of $N$. In particular, 3 measurements suffice when $K = 2$ nonzeros. Practically, our method is very fast, accurate, and very robust against measurement noises. Even when there are no sufficient measurements, the algorithm can still accurately reconstruct a significant portion of the nonzero coordinates, without catastrophic failures (unlike popular methods such as linear programming).

References

Tail behavior of the logarithmic skew normal distribution and its applications

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Key words: Expansion; Large quantile; Logarithmic skew normal distribution; Maximum; Mills’ type ratio; Moment

Abstract

Skewness and asymmetric distributions have received special attention in recent literature. In this talk, we discuss the tail behavior of logarithmic skew-normal distribution (LSN) and its applications. Based on the work of Liao et al. (2012b), we derive higher order representations of the distributional tail of the LSN random variable. This shows that the limiting distribution of suitably normalized maximum of LSN random variables converges to the Gumbel extreme value distribution. Three applications are provided. The first application is to derive asymptotic expansions for the distribution of the maxima of LSN random variables with optimal norming constants. This can be used to deduce the convergence rates of the LSN distribution to its ultimate extreme value distribution. The second application is to derive asymptotic expansions for the moments of the maxima with the same norming constants. The third application is to calculate large quantiles directly through the Mills’ ratio of the LSN.

References

Second-order Tail Asymptotics of Deflated Risks

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Key words: Random deflation; Value-at-Risk; Risk aggregation; Second-order regular variation; Estimation of tail probability

Abstract

Random deflated risk models have been considered in recent literatures. In this paper, we investigate second-order tail behavior of the deflated risk $X = RS$ under the assumptions of second-order regular variation on the survival functions of the risk $R$ and the deflator $S$. Our findings are applied to approximation of Value at Risk, estimation of small tail probability under random deflation and tail asymptotics of aggregated deflated risk

References

Some Asymptotic Results of Nonlinear Functionals of Gaussian Random Fields

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Key words: Gaussian random fields; conditional distribution; asymptotic approximation; change of measure

Abstract

In this talk, we present some recent developments on nonlinear functionals of Gaussian random fields. The results include asymptotic approximations of tail probabilities, density functions, and the conditional distributions of the entire field given the tail events. Central to the analysis is the employment of appropriate change of measures that connect naturally to efficient rare-event simulation algorithms.

References


Closure Properties of the Second-order Regular Variation
Under Randomly Weighted Sums

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Key words: Asymptotics; Second-order regular variation; Randomly weighted sum; Regular variation

Abstract

The closure property of second order regular variation (2RV) under randomly weighted sums is investigated. First, we prove that the sum $\sum_{i=1}^{n} X_i$ preserves the 2RV property, where $X_1, \ldots, X_n$ are independent random variables with 2RV survival functions, which may have different second order parameters. Then, the closure property of 2RV under randomly weighted sums $\sum_{i=1}^{n} \Theta_i X_i$ is considered, where $X_1, \ldots, X_n$ are assumed to be iid with 2RV survival function, and $\Theta_1, \ldots, \Theta_n$ are independent and nonnegative random variables, independent of $X_1, \ldots, X_n$ and satisfying certain moment condition. Finally, we generalize the above for $n = 2$ to dependence case. It is shown that randomly weighted sum $\Theta_1 X_1 + \Theta_2 X_2$ preserves the 2RV, where $X_1$ and $X_2$ are independent, and $(\Theta_1, \Theta_2)$ is independent of $(X_1, X_2)$, but no assumption is made on the dependence structure of $(\Theta_1, \Theta_2)$.

References

Estimation of parameters of regularly varying distributions with an application on planetary perturbations on comets

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Youri Davydov 1
Marc Fouchard 2
Alain Vienne 2
Giovanni Valsecchi 3

Key words: regularly varying distributions; order statistics; stable distributions; estimation of parameters; planetary perturbations

Abstract

An important class of heavy-tailed distributions is the regularly varying distributions of which the stable distributions are a sub-class. As the stable distributions, the regularly varying distributions can be described by four parameters that determine the tail heaviness, asymmetry, scale and position respectively. In this talk we present at first a method for estimating these parameters by using the order statistics. Then the method is applied to a set of planetary perturbations of a huge number of comets during close encounters with planets in order to give a statistical description of these perturbations.

References


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Alternative Methods for Estimating Extreme River Flows

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Key words: Flooding risk; Heffernan and Tawn model; hierarchical factor model; multivariate extreme value; quantile regression; spatial extremes.

Abstract

Flooding is a natural disaster that can cause devastating effect to the society. In dealing with the aftermath of floods two main types of organisation are involved. The first is governmental bodies who manage and plan future investments in the flood defence system. The second are re/insurance companies who provide cover for the financial losses associated with floods.

To assist decision making in either case, a flood event set consisting of simulated events over a long period of time is used for further quantitative analysis such as estimating the potential financial losses etc. The conditional approach for multivariate extremes by Heffernan and Tawn (2004) was applied to generating flood event set in a recent effort by Keef et al. (2012). In this study we will explore two ways of enhancing the parameter estimation for the Heffernan-Tawn model, based on quantile regression and hierarchical factors respectively, and illustrate the impact through a case study.

References

Asymptotic properties of estimators in a stable Cox-Ingersoll-Ross model

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Key words: Stable Cox-Ingersoll-Ross model; conditional least squares estimators; branching process with immigration; exponential ergodicity

Abstract

We study the estimation of a stable Cox-Ingersoll-Ross model, which is a special subcritical continuous-state branching process with immigration. The exponential ergodicity and strong mixing property of the process are proved by a coupling method. The regular variation properties of the model are studied. The key is to establish the convergence of some point processes and partial sums associated with the model. From those results, we derive the consistency and central limit theorems of the conditional least squares estimators and the weighted conditional least squares estimators of the drift parameters based on low frequency observations. The arguments depend heavily on the construction and characterization of the model in terms of some stochastic equations.

References

Relations Between the Spectral Measures and Dependence of Multivariate Extreme Value Distributions

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Key words: Convex order; Multivariate extreme value distribution; Spectral measure; Supermodular order

Abstract

It is well known that the multivariate extreme value distribution (MEV) has a Pickands representation via spectral measure, and the dependence structure of an MEV can be characterized by its spectral measure. In this paper, we investigate the relations between the spectral measure and the dependence of an MEV. More precisely, let $G$ and $G^*$ denote two MEV distributions with spectral measures $S$ and $S^*$ with respect to the $\ell_1$-norm, respectively, and let $W$ and $W^*$ be two random variables taking value on $S_{n-1}$ with probability measure $S(\cdot)/n$ and $S^*(\cdot)/n$, respectively. It is shown that if $W$ is smaller than $W^*$ in the convex order, then $G$ is smaller than $G^*$ in the supermodular dependence order. This means that the more concentrated the spectral measure is, the more positively dependent the MEV is. Some special consequences are also given.

References

Investigating the Goodness-of-Fit of Ten Candidate Distributions and Estimating High Quantiles of Extreme Floods in the Lower Limpopo River Basin, Mozambique

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Key words: goodness-of-fit; generalized extreme value; generalized gamma distribution; extreme floods; high quantiles

Abstract

The study compares ten candidate distributions for their goodness-of-fit in modelling the annual maximum daily flood heights in Mozambique at Chokwe and Sicacate hydrometric stations in the lower Limpopo River Basin. The ten candidate distributions compared in this study were Generalised Gamma (GG), two-parameter Gamma, three-parameter Gamma, two-parameter lognormal, three-parameter lognormal, log-Pearson Type 3 (LP3), Generalised Extreme Value (GEV), two-parameter Weibull, three-parameter Weibull and Gumbel distribution. The candidate distributions were tested for their goodness-of-fit to the data and the best three were used to estimate high quantiles of expected return periods of extreme floods in the Limpopo River Basin of Mozambique. The GEV, Gumbel and GG were the best three distributions at Sicacate based on their ability to model the tails. Three-parameter Gamma, three-parameter lognormal and GEV were the best three distributions at Chokwe. The parameter estimation methods used were the maximum likelihood method, least squares method, method of L-moments and method of moments. Goodness-of-fit was evaluated by means of Kolmogorov-Smirnov and Anderson-Darling tests, as well as P-P plots and simulation studies to check whether the distribution could mimic the observed values. Results of the expected return periods and probable extreme quantiles at both sites Chokwe (upstream) and Sicacate (downstream) indicated that the 13 m flood height of the year 2000 was way higher than the 100-year-flood height based on the best fitting distributions......
On Jakubowski’s approach to limit theory for regularly varying sequences

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Key words: Regularly varying sequence; stable limit; large deviation; Markov chain; drift condition

Abstract

In his SPA papers (1993, 1997), Adam Jakubowski proved stable limit theory for sums of stationary sequences whose marginal distribution has power law tails. In contrast to the paper Davis and Hsing (AoP, 1995) who exploited point process convergence to prove similar results, Jakubowski used classical characteristic function arguments. In this context, he approximated the characteristic function of the standardized partial sums by the difference of the characteristic functions for the standardized sums at two successive indices.

We show that a similar approach works for rather different structures given the underlying sequence is regularly varying and stationary. These structures include maxima, large deviation probabilities for partial sums, point processes. This principle has been applied in a direct way in [1,2] and indirectly in various other papers.

References

Limit Theorems for Maxima in Bivariate Stationary Sequences

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Key words: Bivariate extremes; Stationary sequences; Weak dependence; Asymptotic independence

Abstract

Let $(X_n, Y_n)_{n \geq 1}$ be a bivariate strictly stationary random sequence with the distribution function of its terms $F(x, y) = P\{X_1 \leq x, Y_1 \leq y\}$ and

$$M_n^X = \max\{X_1, \ldots, X_n\}, \quad M_n^Y = \max\{Y_1, \ldots, Y_n\}.$$ 

In this paper we shall determine sufficient conditions under which the limiting distribution of the random vector $(M_n^X, M_n^Y)$ is the same as the limiting distribution of the random vector $(M_n^{X^*}, M_n^{Y^*})$, where

$$M_n^{X^*} = \max\{X_1^*, \ldots, X_n^*\}, \quad M_n^{Y^*} = \max\{Y_1^*, \ldots, Y_n^*\}$$

and $(X_n^*, Y_n^*)_{n \geq 1}$ is an iid sequence of random vectors with the common distribution function $F$. This result can be considered as an extension of Leadbetter’s theorem for univariate stationary sequences; see Leadbetter (1974). Additionally, we shall also get some sufficient conditions for asymptotic independence of components $M_n^X$ and $M_n^Y$. Results can be extended for extremes in sequences of random vectors in $\mathbb{R}^d$, where $d > 2$.

References

Extreme value analysis for emerging African markets

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Key words: Africa; Generalized extreme value distribution; Trends

Abstract

For the first time, we present an extreme value analysis for financial data from Africa. The results of analysis show evidence of emerging economies in Africa. We give future predictions for measures of African economies. The talk will be based on the following published paper.

References

Analysis of heavy rainfall in high dimensions

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Key words: Clustering; Dirichlet mixture; Bayesian non-parametric

Abstract

One of the main objectives of statistical climatology is to extract relevant information hidden in complex spatial-temporal climatological datasets. In impact studies, heavy rainfall are of primary importance for risk assessment linked to floods and other hydrological events. At an hourly and daily time scale, precipitation distributions often strongly differ from Gaussianity. To identify spatial patterns, most well-known statistical techniques are based on the concept of intra and inter clusters variances (like the k-means algorithm or PCA’s) and such approaches based on deviations from the mean may not be the most appropriate strategy in our context of studying rainfall extremes. One additional difficulty resides in the dimension of climatological databases that may gather measurements from hundreds or even thousands of weather stations during many decades. A possible avenue to fill up this methodological gap resides in taking advantage of multivariate extreme value theory and to adapt it to the context of spatial clustering. In this talk, we propose and study two step algorithm based on this plan. Firstly, we adapt a Partitioning Around Medoids (PAM) clustering algorithm proposed by Kaufman to extremes precipitation. This provides a set of homogenous spatial clusters of extremes of reasonable dimension. Secondly, we fine-tune our analysis by fitting a Bayesian Dirichlet mixture model for multivariate extremes within each cluster.

References

Adaptive and computational procedures in extreme value parameters’ estimation

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Key words: Adaptive estimation; Bootstrap; Jackknife; Semi-parametric estimation, Statistics of extremes.

Abstract

Extreme value theory has important applications in a large number of areas, such as hydrology, telecommunications, finance and environmental studies. There are a few parameters of particular interest, among which we refer the extreme value index, $\gamma$, that measures the right tail-weight of the underlying distribution and the extremal index, $\theta$, that characterizes the degree of local dependence in the extremes of a stationary time series. Reliable estimators of these parameters are of great importance, not only by themselves but also because they are the basis for the estimation of other important parameters of rare events such as a high quantile, the probability of exceedance or the expected shortfall. Most semi-parametric estimators of those parameters usually show nice asymptotic properties but high variance for small values of $k$ (the number of upper order statistics used in the estimation) and high bias for large values of $k$. Classical and more recent estimators of those parameters are here revisited. Bootstrap and jackknife procedures are considered for improving the estimators. An adaptive choice of the sample fraction and corresponding estimates of the parameters are performed. A simulation study as well as some applications to real data in environment and finance are provided.
Dense classes of multivariate extreme value distributions

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**Key words:** Multivariate extremes; Extremal dependence, Max-stable; Logistic distributions

**Abstract**

We explore tail dependence modeling in multivariate extreme value distributions through the use of the scale function. This allows combinations of distributions in a very flexible way. The correspondences between the scale function and the spectral measure or the stable tail dependence function are given. Combining scale functions by simple operations, three parametric classes of laws are described and analyzed, and resulting nested and structured models are discussed. Finally, the denseness of each of these classes is shown.

**References**

Partially Optimal Simulation of Max-Stable Processes

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Key words: exact simulation; max-stable process; spectral representation

Abstract

Max-stable processes are frequently used for modelling spatial events, e.g. in environmental sciences. For applications, fast and accurate simulation algorithms for these processes are needed. Schlather [2] proposes an algorithm for mixed moving maxima processes that can be made exact if all shape functions are jointly compactly supported. However, in general, the approximative algorithm includes the simulation of a large number of shape functions, although, finally, only few functions contribute to the process.

In this talk, we consider a max-stable process $Z$ on a domain $T$ with Fréchet margins and general shape functions in a function space $H \subset [0, \infty)^T$:

$$Z(y) = \max_{(t,f) \in \Pi} tf(y), \quad y \in T,$$

where $\Pi$ is a Poisson point process on $(0, \infty) \times H$ with intensity measure $t^{-2} dt \times H(df)$ (cf. [1]). As such a spectral representation is not unique, we aim to find a representation for which the number of shape functions to be simulated for an exact simulation is minimal. We present a partial solution to this optimisation problem. The solution yields an exact algorithm for a large class of max-stable processes including Brown-Resnick processes. In a simulation study, we compare our results to the algorithm of [2].

References

The extremal elliptical Pareto process: Existence, finite-dimensional construction and inference

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Key words: Pareto process; extremal-t dependence structure; ellipticity; extremal Gaussian model; peaks-over-threshold stability

Abstract

Pareto processes generalize the peaks-over-threshold stability of univariate and multivariate Pareto distributions to infinite dimension (see for instance [1], [2], [3]). Constructive approaches for such processes are yet of limited availability. In this talk, we present the extremal elliptical Pareto processes as a class of tractable models whose dependence structure is characterized by a correlation function and a positive shape parameter. The extremal Gaussian dependence structure ([6]) represents a special case (see [5]). We first introduce a generalization of such processes based on the regular variation of stochastic processes (see [4]). Then a construction for the multivariate generalized Pareto distributions of the extremal elliptical Pareto process is provided, rendering numerical simulation workable for real-sized problems with even many sample points. Conditional distributions are of the elliptical-t type and hence easy to interpret and simulate. Finally, we outline some aspects of statistical inference.

References

Kernel regression with Weibull-type tails

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Key words: Extreme value statistics; Weibull-type distribution; regression; second order condition

Abstract

We consider the estimation of the tail index of a Weibull-type distribution in the presence of random covariates. The approach followed is non-parametric and consists of locally weighted estimation in narrow neighborhoods in the covariate space. We introduce two flexible families of estimators and study their asymptotic behavior under some conditions on the conditional response distribution, the weight function, the density function of the independent variables, and for appropriately chosen bandwidth and threshold parameters. We also introduce a Weissman-type estimator for estimating extreme conditional quantiles. The finite sample behavior of the proposed estimators is examined with a small simulation experiment.

References

Functional Limit Theorem for Partial Maxima for Stationary Symmetric $\alpha$-Stable Processes Generated by Conservative Flows

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Key words: Stable process; Fréchet process; long memory; max-stationary increment; conservative flow; pointwise dual ergodicity

Abstract

We derive the functional limit theorem for partial maxima $\max_{1 \leq k \leq nt} |X_k|$, $n = 1, 2, \ldots, t \geq 0$ of stationary $\alpha$-stable processes of a certain integral representation. First of all, we assume that the process is generated by a conservative ow. This assumption relates to the long memory in the process. In particular, the length of memory observed in the process is significantly longer than that in the process generated by a dissipative ow (e.g. moving averages with regularly varying innovations). Moreover, the assumption that the ow is pointwise dual ergodic allows us to quantify the memory length in the process by the parameter $\beta \in (1/2, 1)$. Consequently, the normalizing constants $(b_n)$ of the partial maxima forms a regularly varying sequence with index $\beta/\alpha$. Furthermore, the limiting process of the normalized partial maxima is no longer a classical extremal process and is, in fact, a new class of self-similar $\alpha$-Fréchet process with max-stationary increments. The functional limit theorem is established in the space $D[0, \infty)$ equipped with the Skorohod $M_1$-topology; however, if the integral representation of the process takes a simple form, we can strengthen the topology of $D[0, \infty)$ to the Skorohod $J_1$-topology. This is because, in that case, $b_n^{-1} \max_{1 \leq k \leq nt} |X_k|$ possesses ”single jump structure”, while in a general case, it has ”multiple jump structure”.

70
The Second-order Version of Karamata’s Theorem With Applications

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Key words: Conditional moment; Extreme value theory; Karamata’s theorem; Regular variation; Second-order regular variation.

Abstract

The Karamata’s theorem is well known, which examines the integral properties of regular variation functions. In this paper, we obtain the second-order version of Karamata’s theorem, and give its one application in characterizing the second-order regular variation property of a survival function in terms of conditional moments.

References


Extended generalised Pareto models for tail estimation

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Keywords: Tail estimation; generalised Pareto; threshold selection; threshold uncertainty

Abstract

The most popular approach in extreme value statistics is the modelling of threshold exceedances using the asymptotically motivated generalised Pareto distribution. This approach involves the selection of a high threshold above which the model fits the data well. Sometimes, few observations of a measurement process might be recorded in applications and so selecting a high quantile of the sample as the threshold, leads to almost no exceedances. In this talk we discuss extensions of the generalised Pareto distribution that incorporate an additional shape parameter while keeping the tail behaviour unaffected. The inclusion of this parameter offers additional structure for the main body of the distribution, improves the stability of the modified scale, tail index and return level estimates to threshold choice and allows a lower threshold to be selected. We illustrate the benefits of the proposed models with a simulation study and two case studies.
Estimating bivariate t-copulas via Kendall’s tau

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Key words:

Abstract

Copula models have been popular in risk management. Due to properties of the asymptotic dependence and the easy simulation, the t-copula has often been employed in practice. A computationally simple estimation procedure for the t-copula is to first estimate the linear correlation via Kendall’s tau estimator and then to estimate the parameter of the number of degrees of freedom by maximizing the pseudo likelihood function. In this paper, we derive the asymptotic limit of this two-step estimator which results in a complicated asymptotic covariance matrix. Further, we propose jackknife empirical likelihood methods to construct confidence intervals/regions for the parameters and the tail dependence coefficient without estimating any additional quantities. A simulation study shows that the proposed methods perform well in finite sample.
Penalized maximum likelihood estimation for the endpoint and exponent of a distribution

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**Key words:** Endpoint; Exponent; Non-regularity; Limiting distribution; Maximum likelihood

**Abstract**

Consider a random sample from a regularly varying distribution function with a finite right endpoint $\theta$ and an exponent $\alpha$ of regular variation. The primary interest of the paper is to estimate both the endpoint and the exponent. Since the distribution is semiparametric and the endpoint and the exponent reveal asymptotic properties of the right tail for the distribution, estimates for both parameters involve only a few largest observations from the sample. The conventional maximum likelihood method can be used to estimate both $\alpha$ and $\theta$, see e.g., Hall (1982) (Ann. Statist. 10, 556 – 568) for regular cases when $\alpha \geq 2$, and Smith (1987) (Ann. Statist. 15, 1174 – 1207), Dress, Ferreira and de Haan (2004) (Ann. Appl. Probab. 14, 1179 – 1201.) and Peng and Qi (2009) (J. Statist. Plann. Inference 139, 3361 – 3376) for non-regular cases when $\alpha \in (1, 2)$. The global maximum of the likelihood function doesn’t exist if one allows $\alpha \in (0, 1]$, and a local maximum exists with probability tending to one only if $\alpha > 1$. Therefore, the maximum likelihood method fails when $\alpha \in (0, 1]$. In this paper we propose a penalized likelihood method to estimate both parameters. The use of the new method requires no prior information on the exponent, the penalized likelihood function is always bounded, and the estimates from this new likelihood exist in all cases. We present the asymptotic distributions for the estimates from the new method. Our simulation study shows that the proposed method has better finite sample properties than the conventional maximum likelihood method in regular cases.
Systemic Risk Allocation for Systems with A Small Number of Banks

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Key words: Extreme value theory; Systemic risk allocation; Marginal expected shortfall; Systemically important financial institutions

Abstract

This paper provides a new estimation method for the marginal expected shortfall (MES) based on multivariate extreme value theory. In contrast to previous studies, the method does not assume specific dependence structure among bank equity returns and is applicable to both large and small systems. Furthermore, our MES estimator inherits the theoretical additive property. Thus, it serves as a tool to allocate systemic risk. We apply the proposed method to 29 global systemically important financial institutions (G-SIFIs) to evaluate the cross sections and dynamics of the systemic risk allocation. We show that allocating systemic risk according to either size or individual risk is imperfect and can be unfair. Before 2008, the EU banks take excessive systemic risk with respect to the size, while the US banks take less systemic risk. This pattern is reversed after 2008. We find an opposite result for the allocation fairness with respect to individual risk. Between the allocation with respect to individual risk and that with respect to size, the former is less unfair. On the time dimension, both allocation fairness across all the G-SIFIs has decreased since 2008.

1The research of Xiao Qin has received funding from NSFC under grant number 71001070 and the NSFC-NWO grant (No. 71211130310 and No. 2012/07448/BOO). The fundings are gratefully acknowledged. A large part of the work is done when Xiao Qin was visiting Erasmus University Rotterdam and she thanks Erasmus School of Economics for their hospitality. Views expressed are those of the authors and do not reflect the official positions of De Nederlandsche Bank.
Tail estimation for window-censored 0-1 processes

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Key words: Sizebiased sampling; Generalized Pareto Distribution; traffic safety

Abstract

This talk is about estimating the distribution, and in particular the tail distribution, of the length of the 0-intervals in a continuous time stationary ergodic stochastic process which in alternating intervals take the values 0 and 1. Here 1 could mean that a technical system is functioning while 0 indicates that it is out of function, or 1 could be that an individual is healthy, while 0 is that he has a specific recurrent disease. In the problem which initiated this research, 0 indicates that the driver of a car looks on the road, and 0 that she looks away from the road. The setting is that many such processes have been observed during a short time window. Thus the 0-intervals which fall in the observation window could be noncensored, right censored, left censored or doubly censored. Additionally, the lengths of the 0-intervals which are ongoing at the start of the observation window have a size-biased distribution. We derive ML estimation methods assuming a full parametric model, and ML methods for a semiparametric model which assumes a Generalized Pareto form for the tail of the distribution. Finite sample properties of the methods are studied by simulation, and the methods are applied to estimation of the length of off-road glances in the 100-car study, a big naturalistic driving study.
Extreme precipitation in a changing climate: A regional POT approach

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Key words: non-stationarity; POT; regional frequency analysis

Abstract

The statistics of extreme precipitation events is crucial for the planning and the design of hydraulic infrastructure. Consensus is growing that the characteristics of extreme precipitation may alter owing to climate change, which contradicts the stationarity assumption that is usually made in the analysis of extreme precipitation. The consideration of time-varying parameters allows to take the full length of the time series into account. This reduces the sampling variability and estimation uncertainty, compared to using only a time slice for the present day climate and a time slice for future conditions. However, the estimation of large quantiles of extreme precipitation in these models is still subject to high uncertainty. A way to reduce this uncertainty is through regional frequency analysis (RFA), where the similarities between different sites in a region are exploited.

We developed a regional peaks-over-threshold (POT) model, that can be used to analyze precipitation extremes in a changing climate. A temporally varying threshold, which is determined by quantile regression, is used to account for changes in the frequency of precipitation extremes. The marginal distributions of the excesses are described by generalized Pareto distributions (GPD). The parameters of these distributions may vary over time and their spatial variation is modeled by the index flood (IF) approach.

The method is applied to daily precipitation in the Netherlands and a part of north-western Germany. We compare the results from two regional climate model simulations for the period 1950 to 2100 with results from gridded observational data. Bias corrected projections of high quantiles are presented. It is shown that the estimation uncertainty is substantially reduced by RFA and that it is more likely to detect existing trends, compared to a at-site analysis.
On the existence of paths between points in high level excursion sets of Gaussian random fields

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Key words: Gaussian random field, excursion set, connected components, large deviations

Abstract

The structure of Gaussian random fields over high levels is a well researched and well understood area, particularly if the field is smooth. However, the question as to whether or not two or more points which lie in an excursion set belong to the same connected component has eluded analysis. We study this problem from the point of view of large deviations, analyzing the asymptotic probabilities that two such points are connected by a path laying within the excursion set, and so belong to the same component. This problem turns out to be intimately related to the problem of finding minimal energy measures with respect to the covariance kernel of the field. We characterize such measures, and prove that the optimal (most likely) paths are, in fact, the minimal capacity paths. We will conclude with considering the case of two points far away from each other, and observing the difference between the short and long memory cases.
Exact Moderate and Large Deviations for Linear Processes

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Key words: linear process, long memory, moderate deviation, large deviation, zone of normal convergence, non-logarithmic asymptotics

Abstract

Large and moderate deviation probabilities play an important role in many applied areas, such as insurance and risk analysis. This paper studies the exact moderate and large deviation asymptotics in non-logarithmic form for linear processes with independent innovations. The linear processes we analyze are general and therefore they include the long memory case. We give an asymptotic representation for probability of the tail of the normalized sums and specify the zones in which it can be approximated either by a standard normal distribution or by the marginal distribution of the innovation process. The results are then applied to regression estimates, moving averages, fractionally integrated processes, linear processes with regularly varying exponents and functions of linear processes.

References

Extreme Value Mixture Models - An R Package and Simulation Study

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Key words: Mixture Model; Threshold Estimation; R Package evmix; Simulation study

Abstract

There are a plethora of extreme value mixture models which combine a classic tail model with a component to describe the bulk of the distribution. A review of such mixture models and other threshold estimation approaches is provided by Scarrott and MacDonald (2012). The threshold is typically treated as parameter to be inferred, thus permitting both estimation and uncertainty quantification. Thus potentially providing a more objective approach to threshold choice, than the traditional graphical diagnostics.

We have created an R package which implements most of the existing mixture models. Alongside the author’s original derivation, they have all been placed in a more generalised framework where the proportion above the threshold ($\phi_u = P(X > u)$) is either: (1) treated as a parameter to be estimated (for which the mle is the sample proportion) or (2) inferred by the proportion of the bulk model which, if defined over it’s support, is above the threshold. The original derivations of these mixture models have arbitrarily used one of these definitions with no formal or empirical justification. The models are also extended to permit a constraint of continuous density at the threshold.

The R package called evmix will be available on CRAN to increase the usability of such mixture models in the wider extremal community. This talk will demonstrate usage of the package and will show the results of simulation studies comparing the performance of the generalised mixture models.

References

Extremal Dependence of Markov Chains: Walking Backwards and Forwards in Time

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Key words: cluster; Markov chain; regular variation; spectral process

Abstract

The asymptotic distribution of a cluster of extremes in a weakly dependent, stationary time series is fully determined by the conditional distribution of the series given that at a specific time point, an extreme value is produced. The limiting conditional distribution of the original series, properly normalized, given such an event is called the spectral process. The spectral process satisfies a remarkable system of equations that express the effect of a time shift on the distribution of a finite stretch of the spectral process.

For stationary, regularly varying Markov chains, the spectral process is Markovian too. The distributions of its forward and backward increments at positive and negative times are linked through an adjoint relation governed by the index of regular variation.

It follows that for a large class of Markov processes, clusters of extremes follow a law that is determined by the distribution of the forward increment of the spectral process. The forward–backward duality imposes a challenging shape constraint in the estimation problem.
Supremum Location and Stationarity

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Key words: supremum location; stationary process; bounded variation

Abstract

We firstly consider the distributions of the supremum location for stationary processes in a compact interval. It is proved that the distribution must satisfy certain properties, such as the absolute continuity in the interior of the interval, and a group of constraints on the total variation of the density function. In the next step, the results are generalized to a large family of random locations called ”intrinsic location functionals”, which includes supremum/infimum locations, hitting times, etc. It is further shown that the list of properties that we obtained for the distributions are actually equivalent to stationarity of the process, in the sense that a process is stationary if and only if all the intrinsic location functionals satisfy the list of properties. In this way we get an alternative characterization of stationarity from the perspective of random locations. Finally we go back to extremes, by showing that any random location in this family is actually taking the location of the maximal element of a random set, according to some random order, both determined by the path.

References

Discretization of distributions in the maximum domain of attraction

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Key words: Maximum domain of attraction; Discretization; Gumbel distribution; Roundoff error

Abstract

The max-domain of attraction (maximum domain of attraction) covers wide-ranging continuous distributions. On the other hand, it does not contain common discrete distributions such as the Poisson and geometric distribution. Particularly, while the geometric distribution does not belong to the max-domain of attraction of Gumbel distribution, its continuous counterpart, the exponential distribution does. It implies that the discretization of distribution may spoil the property of the max-domain of attraction, and also a roundoff error has a bad influence from the statistical point of view. The discretization of distribution implies the transformation from a distribution into a discrete distribution by concentrating the mass of the interval $(n-1,n]$ to the point $\{n\}$ for each integer $n$. We try to regard a discrete distribution as a discretization of a distribution in the max-domain of attraction. If a discrete distribution is considered to be such a discretization, we say the distribution is recoverable to the max-domain of attraction.

A discrete distribution $F_1$ is recoverable to the max-domain of attraction of Gumbel distribution if

$$\lim_{n \to \infty} \left( \log \frac{F_1(n+1)}{F_1(n+2)} \right)^{-1} - \left( \log \frac{F_1(n)}{F_1(n+1)} \right)^{-1} = 0. \quad (1)$$

(1) is also essentially necessary for the recovery to the max-domain of attraction of Gumbel distribution.

References

Regularly varying time series with asymptotic independence

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Key words: Regularly varying time series, asymptotic independence, conditional distributions

Abstract

A stationary time series is said to be regularly varying if all its finite dimensional distribution exhibit multivariate regular variation. Examples widely used in financial econometrics include the GARCH process and the so-called SV (stochastic volatility) process with heavy tailed innovations. The multivariate extremal properties of these processes differ fundamentally: the finite dimensional distributions of the GARCH process are asymptotically dependent, and those of the SV process are asymptotically independent. Asymptotic dependence means that exceedences over high threshold occur in clusters. This is the case of the GARCH process. To the contrary, asymptotic independence means that extremes occur in isolation; this is the case of the SV process. However, in both cases, a very high value does have influence on the following values, and it is of interest to model and estimate this influence. In the case of asymptotic dependence, many tools are available. In the case of asymptotic independence, these tools are usually degenerate. A more appropriate approach is to study the limiting conditional distribution of a suitably normalized future value of the time series, given the present one exceeds a high threshold. Such conditional distribution have been investigated by Kulik and Soulier (2012) for the SV process. In this talk, we will present new time series models with asymptotically independent regularly varying finite dimensional distribution and related statistical methodology.

References

All tail correlation functions are realized by max-stable processes

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Key words: max-stable process; positive definite function; tail correlation; tail dependence coefficient

Abstract

Let $X = \{X_t\}_{t \in T}$ be a stochastic process with the same one-dimensional marginals and upper endpoint $x^*$. Assuming that the following limits exist

$$
\chi(s, t) := \lim_{x \to x^*} \mathbb{P}(X_s \geq x | X_t \geq x),
$$

the function $\chi$ will be called the tail correlation function (TCF) of the process $X$. In the literature the TCF $\chi$ is considered as an analogue to the correlation function for extreme values [1,2,3]. It is well-known that TCFs are non-negative correlation functions, but not all non-negative correlation functions are TCFs. Nonetheless, both classes have desirable properties in common: (i) TCFs can be completely characterized by finite-dimensional inequalities and (ii) convex combinations, products and pointwise limits are admissible operations on TCFs. Since we also identify rich classes of TCFs, this allows to build advanced TCFs from these basic construction principles. Finally, we show that any TCF $\chi$ can be realized by a max-stable process $X$.

References

Statistical Methods for Association Studies of Rare Variants

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Key words: rare variants; robust statistics; Fishers method; genetic association studies; next generation sequencing

Abstract

In the search for genetic factors that are associated with complex human diseases and traits, there is now much interest in understanding the role of rare variants (as represented by SNPs with small minor allele frequency in a population). In response, numerous recent papers have proposed testing strategies to assess association between a group of rare variants and a trait, with competing claims about the performance of various tests. We first review previously proposed methods within a general framework and categorize them as either linear statistics that have high power against very specific alternative hypotheses or quadratic statistics that are designed to have good power over wide ranges of alternatives. However, neither class of tests consistently outperforms the other or provides comparable power. To achieve robustness, we then propose hybrid statistics that borrow strength from the two classes of tests using Fisher’s method and the minimal p-value approach of combining p-values from the complementary linear and quadratic tests. Extensive simulation studies and applications show that both methods are robust across genetic models. Moreover, in situations when both the linear and quadratic tests have some power, Fisher’s method consistently outperforms the minimum-p and the individual linear and quadratic tests, as well as the optimal sequence kernel association test, SKAT-O [1,2].

References

On estimation and prediction for bivariate extreme value distributions

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Key words: Bivariate extreme value distribution, bootstrap, calibration, dependence function, marginal distribution, nonparametric curve estimation

Abstract

There are at least two equivalent characterizations of bivariate extreme value distributions based on either a so called spectral measure or a function which has been named dependence function. In this talk we explore the relationship between these two characterizations and discuss how it can be used for statistical inference. We give also a review of the existing estimation and prediction methods for bivariate extremes.

As an application we consider rainfall data from Thailand. In 2011 the country experienced its worst floods in 61-years (1951-2011). We analyze historical daily rainfall data from eight meteorological stations in northeast Thailand and show how extreme value theory can be used to estimate the risks for similar floods in the future.
The limit theorems for maxima of stationary Gaussian processes with random index

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Key words: limit theorem; weak convergence; maxima; random index; stationary Gaussian process

Abstract

Let \( \{X(t), t \geq 0\} \) be a standard (zero-mean, unit-variance) stationary Gaussian process with correlation function \( r(\cdot) \) and continuous sample paths. In this paper, we consider the maxima \( M(T) = \max\{X(t), \forall t \in [0, T]\} \) with random index \( T_T \), where \( T_T/T \) converges to a non-degenerate distribution or to a positive random variable in probability, and show that the limit distribution of \( M(T_T) \) exists under some additional conditions related to the correlation function \( r(\cdot) \).

References

Threshold modelling of spatial extremes

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Key words: Max-stable processes; Generalized Pareto distribution; Composite likelihood; Asymptotic (in)dependence; Rainfall modelling

Abstract

Complex extreme events, such as heat-waves and flooding, have major effects on human populations and environmental sustainability, and there is growing interest in modelling them realistically. When individual events are recorded, threshold exceedances can be modelled using the generalized Pareto distribution. For risk assessment based on spatial environmental processes, it is necessary to properly model the dependence among extremes at several locations, and understand how the dependence varies spatially. Natural models for spatial extremes are max-stable processes, which allow dependence at infinitely extremal levels. Max-stable models have been proposed for various types of data and can be fitted using pairwise likelihood, where properties are similar to those of classical likelihood inference. However, assuming extremal dependence may be too restrictive and, in some applications, asymptotic independence models, for which dependence decreases with the severity of the events, may be more appropriate. One asymptotic independence model is the Gaussian copula model, but a larger class of such models can be constructed by inverting max-stable processes. This presentation will describe the major issues in such modelling, and illustrate them with an application to extreme rainfall in Switzerland.

References

Comparison of Market Risk Models of Different Classes

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Key words: FX rates; market risk measuring; backtesting; tails; EVT; GARCH; Lvy models

Abstract

A core part of (risk) management of financial institutions is to run an appropriate risk model. Such model is commonly based on estimation of the quantile or conditional quantile of the probability distribution of portfolio returns. As concerns market risk, the distribution of returns is relatively symmetric (compare to credit or operational risk), but fat tails are often present. Since both, market supervisors and other stakeholder opt for healthy financial system and its entities, interest in far tails is evident. The empirical observations, however, show that such tails can be often very heavy and thus standard models based on normal distribution are not sufficient. In this contribution, several alternatives, belonging to various class of models (extreme value theory, GARCH, Lvy models with subordinator) are compared and their performance with FX rate risk estimation is analyzed via backtesting procedure.
Statistical downscaling of the extreme wave climate of the
North Sea

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Key words: Climate modelling, oceanography and statistical downscaling

Abstract

Operational windows for offshore operations are characterised by oceanographic conditions and in particular the largest waves. Information for safe operating windows can be obtained by characterising the distributional changes in extreme waves. We apply a statistical downscaling algorithm to use data from large scale (low resolution) climate models to make predictions of the future extreme wave climate at locations in the North Sea. In order to make projections that account for the effects of climate change, both historical and future predictions are obtained from the HADGEM2 global climate model (GCM). Variables available from the GCM include wind speed and wind direction. Currently future projections of wave heights are only provided at a monthly scale, which is not sufficient as storms typically last only a couple of days.

In order to predict the future distribution of extreme wave heights, we propose a two-step statistical downscaling model. As wind direction and wind speed are key factors in determining wave heights, we firstly derive a parametric model to predict each of these variables at a given location by modelling the variable at the local scale (the hindcast data) as a function of the corresponding variable at the larger scale (the GCM data). Next an extreme value model for wave heights at the local scale is developed, which describes the relationship between wind speed and wind direction and extreme wave heights. The hindcast data is used to estimate the parameters in this model. Future predictions of extreme wave heights can then be made by estimating future local scale wind speed and wind direction using the first model, combined with the GCM predictions. These local wind speed and wind direction predictions are then inserted into the second model to give the required wave height predictions.
Toward a new approach to estimation of high quantiles

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Key words: regular variation; extreme value theory; quantile estimation; tail; high quantile; Generalised Weibull distribution; monotonic function

Abstract

To estimate a quantile from a sample of $n$ iid random variables at a probability of exceedance $p_n = O(1/n)$ (i.e., a high quantile), a Generalised Pareto (GP) tail approximation is often applied. Theory supports this if in addition to regular variation of $U$ (the inverse of $1/(1 - F)$), a certain rate for the convergence to the GP tail limit is assumed. Two types of assumptions are common: (a) a relatively fast rate (e.g. strong 2nd-order extended regular variation), or (b) a slower rate, $1/p_n = O(n)$ and estimators are based on a small number $k_n$ of upper order statistics, typically $k_n \sim \log n$ as $n \to \infty$. Condition (a) is very restrictive, and (b) is not applicable if $p_n$ vanishes more rapidly than $1/n$. This presentation explores the use of alternative tail models for the approximation of very high quantiles at $p_n = n^{-\tau}$ for some $\tau > 1$ from intermediate quantiles, which can be estimated from data. A stretched quantile is defined as a convenient analytical surrogate for a high quantile, and a Generalised Weibull (GW) family of distribution functions is shown to characterise limits for the logarithms of stretched quantiles in the same way as the GP family characterises the classical extreme value limits by extended regular variation. Existence of such a log-GW limit for stretched quantiles (as well as existence of a GW limit, a special case) implies that certain probability-based approximation errors vanish locally uniformly for stretched quantiles. As a demonstration, a simple high quantile estimator based on a local log-GW tail model is formulated and can be shown to be strongly consistent for very high quantiles if a log-GW limit exists. A numerical simulation illustrates the results.
Drought propagation in the Czech Republic by resampling data with weather generators

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Key words: Extremes; Hydrologic regime; Weather generator; Drought; Climate change

Abstract

Impact of climate change on hydrologic regime has many uncertainties, which is necessary to quantify and eliminate. Basic problems are choices of hydrologic model, regional and global climate model and their short term time series, which affect prediction and quantification extremes events for reference period. The other problem is comparison basins drought indices as P-E, SPI, PDSI and deficits methods of discharges, threshold level method and sequent peak algorithm. In present study, sensitivity analysis is applied for assessing impact of climate change on hydrologic regime with focus on low flow characteristics and drought propagation through each type of drought, which are represented by drought indices P-E, SPI, PDSI and deficit indices. Inputs are 30 years data resampled by three weather generators to daily 500 years time series and reference period (2025s, 2055s and 2085s) combined with over than 15 RCM. For each period were selected 100 events and were evaluated propagation of drought through the system by standardized indices. These events were assessed statistically and were dedicated their GEV probabilities. At this time are assessed 10 basins in the Czech Republic and the results indicate increasing of droughts events and their intensity. When are comparing 30years observed data with resampled data for them same period, we are finding more low flow and drought characteristics correspondents with long term observations. With time the propagation of drought is changing. It is based on precipitation outputs of regional climate models and methods which compute meteorological drought indices. N-year occurrence of minimum flows are changing and probability of low flows is higher.
Efficient inference for spatial extremes, and some thoughts beyond max-stability

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Key words: Spatial extremes; max-stable processes; likelihood inference; asymptotic independence

Abstract

Max-stable processes form one useful characterization of for extreme values of spatial processes. Inference for these processes has been largely restricted to pairwise composite likelihoods, due partially to intractability of higher dimensional distributions, and partially to the very large number of summands involved in higher dimensional densities. We discuss the application of a censored Poisson process likelihood, which reduces the number of summands to one. For a large class of max-stable processes based on log-Gaussian random functions, we are able to calculate neat forms for all the required terms, and thus make inference practicable in $d$-dimensions. Max-stable processes are not however applicable as models for extreme values of all spatial processes. Those exhibiting the phenomenon of asymptotic independence require alternative strategies, since max-stable processes will overestimate the level of dependence in the extremes. An alternative modelling strategy for such processes is also discussed.
Likelihood Moment Estimation for the Three-Parameter Generalized Pareto Distribution

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Key words: Generalized Pareto Distribution; Likelihood Moment Estimation; Asymptotic Distribution; Extremal Data

Abstract

In the peaks-over-threshold (POT) model, the Generalized Pareto Distribution (G-PD) is commonly used to fit the distribution of the excess $X_i - u$, where $u$ is the threshold. Zhang (2007) proposed a new estimation method-likelihood moment estimation (LM) for 2-parameter GPD, which is computationally easy and has high asymptotic efficiency with respect to traditional methods. This method has been extended to 3-parameter GPD in present paper. The result shows that the asymptotic property of estimators for scale and shape parameter is the same as that of Zhang (2007). Moreover, the LM estimator for 3-parameter GPD always exists, is simple to compute and is close to the lowest bias and mse over a wide range of shape parameters (the same comment by Mackay et al (2011) for LM for 2-parameter GPD).

References

Some new dependence structures of random variables and its applications

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Key words: sums of random variable; dependence structures; heavy-tailed distributions; ruin probability;

Abstract

In this paper, we investigate the tail asymptotic behavior of the partial sums, the random sums and the weighted sums of heavy-tailed random variables (r.v.s) under two new dependence structures, respectively. The tailed distributions of the above r.v.s belong to the class $S_d$, while the dependence structures can contain common linearly negatively quadrant dependent r.v.s, some positively dependent r.v.s and some other r.v.s. The obtained results are used to derive the asymptotic estimation of the finite-time ruin probability in a nonstandard renewal risk model. Finally, some mutual relations among these two new dependence structures and some other relevant ones are discussed.

References

Limiting distribution for maximal standardized increment of a random walk

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Key words: Random walk; set-indexed partial sum; moderate deviation; large deviation, double-sum method

Abstract

We investigate the limiting distribution of the largest jump over all intervals between $[1, n]$, after standardization, of a random walk. We assume that the jump distribution has finite Laplace transform. We show that although most of the cases the limiting distribution is Gumbel, as in the Gaussian case, the normalization rates may have different orders. In particular, we distinguish 4 different cases in term of the log-Laplace transform of the jump distribution. Our results cover most widely-applied light-tailed distributions.

References

A Sum Characterization of Hidden Regular Variation with Likelihood Inference via the EM Algorithm

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Key words: Multivariate Extreme Value Theory; Threshold Exceedance Modeling; Asymptotic Independence; Air Pollution

Abstract

In this work, we examine multivariate threshold modeling based on the framework of regular variation on cones. Under this framework, a limiting measure arises which describes the dependence in the joint tail of the distribution. When hidden regular variation is present, this limiting measure is degenerate on some joint tail regions, and a modeling approach based on the limiting measure may break down. For example, such an approach is unable to distinguish asymptotic independence from exact independence in two dimensions. This work develops a representation of random vectors possessing hidden regular variation as the sum of independent regular varying components. The representation is shown to be asymptotically valid via a multivariate tail equivalence result, and an example is demonstrated via simulation. We develop a likelihood-based estimation procedure from this representation via a version of the Monte Carlo expectation–maximization algorithm which has been modified for tail estimation. The methodology is demonstrated on simulated data and applied to a bivariate series of air pollution data from Leeds, UK. We demonstrate the improvement in tail risk estimates offered by the sum representation over approaches which ignore hidden regular variation in the data.

References

A scaled normal comparison inequality and its applications

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**Key words:** Comparison inequality; Exceedances point process; Limit distribution; Scaled normal sequence

**Abstract**

In this paper, we derive a comparison inequality of scaled normal sequences under the condition of random scaling is bounded or unbounded, respectively. Further, using the scaled normal comparison inequality, we obtain the limit distribution of exceedances point processes of deflated or inflated stationary normal sequences.

**References**


The cluster index of regularly varying sequences with applications to limit theory for functions of multivariate Markov chains

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Key words: Markov processes, Regular variation, Central limit theorem, Large deviation principle, GARCH

Abstract

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

References

A Spatio-directional splines Model for Extreme Waves in the Gulf of Mexico

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Key words: marginal Spatio-directional extremes; covariate effect; splines

Abstract

Storm severity varies systematically with numerous covariates, including location and storm direction. Reliable estimation of design criteria requires adequate incorporation of covariate effects within extreme value models. We present a spatio-directional model for extreme storm peak significant wave heights in the Gulf of Mexico motivated based on the nonhomogeneous Poisson model for peaks over threshold. The model is illustrated using a neighbourhood of spatial locations from the proprietary Gulf of Mexico Oceanographic Study (GOMOS) hindcast for the US region of the Gulf of Mexico for the period of 1900 - 2005. Marginal directional and spatial variability are incorporated as smooth spatio-directional variation of model parameters in the model components, namely extreme value threshold estimation (using quantile regression), estimation of rate of occurrence of threshold exceedance (using a Poisson point process model), and estimation of size of occurrence of threshold exceedance (using a generalised Pareto model). Parameters are expressed in terms spatio-directional p-spline forms throughout, and parameter smoothness is imposed using parameter roughness-penalised estimation throughout. Roughness penalties are evaluated using cross-validation, and modelling uncertainty quantified using bootstrap resampling. The model produces estimates for design values which are consistent with physical understanding and previous estimates.

References

Geometry and Excursion Probability of Multivariate Gaussian Random Fields

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Key words: Multivariate Gaussian random fields; cross-covariance; smoothness; mean Euler characteristic; fractal properties; excursion probability.

Abstract

Multivariate Gaussian random fields with dependent components have attracted increasing attention in probability, statistics and their applications. These random fields have rich geometric and statistical properties. However, problems on their excursion probabilities seem challenging, and few results are available.

In this talk we provide some preliminary results on geometry and excursion probabilities of multivariate Gaussian random fields, where the cross covariance structures play an important role.
Pricing $k^{th}$ Realization Derivatives with $C^{A,B}$ Copula

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**Key words:** $C^{A,B}$ copula; $k^{th}$-realization derivative; basket default swap; CDO

**Abstract**

In financial market, many important derivatives are written on multi-names. Modeling correlation among underlying assets is crucial and copula method has been widely applied in this area. We propose to use the copula family presented in Yang, Qi and Wang (2009) to price multivariate financial instruments whose payoffs depend on the $k^{th}$ realization of the underlying assets. The advantage of the dependency assumption on numerical calculating is discussed.

**References**

On Variance of Quantiles of Weighted Sample

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Key words: Bootstrap; Importance Sampling; Asymptotic Theory

Abstract

Importance sampling is a widely used variance reduction technique to compute sample quantiles such as value-at-risk. The variance of the weighted sample quantile estimator is usually a difficult quantity to compute. We present the exact convergence rate and asymptotic distributions of the bootstrap variance estimators for quantiles of weighted empirical distributions. Under regularity conditions, we show that the bootstrap variance estimator is asymptotically normal and has relative standard deviation of order $O(n^{-1/4})$. An application to extreme quantiles is discussed.

References

On Extremal behaviour of aggregation of largest claims

Yang Yang (poster)
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Key words: Largest claim reinsurance; ECOMOR reinsurance; random weights; long-tailed distribution; dominated-varying tailed distribution

Abstract

In this paper some dependent risks are considered, and tail asymptotic probabilities for linear combinations of finite number or random number of randomly weighted order statistics are estimated under various assumptions, where the primary random variables have long and dominatedly varying tails. Our findings are highly motivated by the need of the investigation of extremal behavior of aggregation of large claims, and are applicable to both largest claim reinsurance treaty and ECOMOR one as shown in Asimit et al. (2012).

References

Randomly Weighted Sums of Subexponential Random Variables in Insurance and Finance

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Key words: Asymptotics; Capital allocation; Matuszewska indices; Randomly weighted sum; Subexponentiality

Abstract

Motivated by applications in insurance and finance, we study the tail behavior of the randomly weighted sum $\sum_{i=1}^{n} \theta_i X_i$. Suppose that the primary random variables $X_1, \ldots, X_n$ are real valued, independent and subexponentially distributed, while the random weights $\theta_1, \ldots, \theta_n$ are nonnegative and arbitrarily dependent, but independent of $X_1, \ldots, X_n$. For various cases, we prove that the tail probability of $\sum_{i=1}^{n} \theta_i X_i$ is asymptotically equivalent to the sum of the tail probabilities of $\theta_1 X_1$, $\ldots, \theta_n X_n$, which complies with the principle of a single big jump. The results significantly improve the work of Tang and Tsitsiashvili (2003, Extremes). An application to capital allocation is proposed.
Extreme value analysis of hydrological-agricultural drought

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Anne Gobin

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Key words: Drought; Spatial Generalized Extreme Value; Kriging; Return-level maps

Abstract

A considerable part of economy relies on the agro-ecosystem. Despite technological advances, the impact of weather conditions on the agricultural productivity remains an important factor. In agro-ecosystem, drought can have large impacts on the economical and agricultural aspects. Based on the widely-used definition of drought [1], the precipitation deficit for any period of the year is the difference between the precipitation and potential evaporation for that period, hydrological drought. In case of agricultural drought, four types of potential evapotranspiration (from water surface, short grass, deciduous and coniferous forest) were considered. The evapotranspiration data were obtained using the Penmann formula [2]. Series of 40-years were available at 13 hydro-meteorological stations across Belgium. The annual maxima of accumulated precipitation deficit for summer half-year is obtained at each station separately. Aspatial linear regression model based on Generalize Extreme Value (GEV) theory [3, 4] and universal kriging are compared. In both methods, distance to the sea among mean annual rainfall and altitude is used as covariate. The results of statistical tests and prediction comparison tests [3] revealed an equivalent performance for both methods. Finally a 20-year return-level map of drought in Belgium is shown.

References


How frequent has the extreme weather become in China?

Hao Zhang (speaker)
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Key words:

Abstract

It is common belief that the climate has and will become more extreme in both frequency and magnitude. However, in light of global warming, it is an interesting problem to describe exactly how much more frequent the climate or weather has become. For example, a temperature that was considered extremely high may no longer be an extreme one because of the upward trend in the mean temperature. In this talk, I will try to answer the question in the title by introducing some measures that are time dependent. I will show how frequent the major cities and provinces have become in the last 20 years across China by analyzing over 750 national weather stations that have been observed since 1951. The primary statistical methods behind the results are those for the inhomogeneous Poisson processes.
Examining Tail Dependence in Large Scale Precipitation Data Across Continental USA

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Key words:

Abstract

In recent years, extreme climatic conditions are more often observed, where a subset of climate variables are not only dependent, but also tail dependent. Identification of tail dependence among observations is important and challenging, but remains an open problem, due to the fact that tail dependence is primarily captured by values above thresholds. This paper introduces a class of tail quotient correlation coefficients (TQCC) which allows the underlying threshold values to be random. The limiting distribution of TQCC under the null hypothesis of tail independence is derived. Test statistics for tail independence are constructed and shown to be consistent under the alternative hypothesis of tail dependence. We apply TQCC to investigate tail dependence of daily precipitation in US during 1950–1999 recorded at 5873 stations from the National Climate Data Center rain gauge data. Our results indicate nonstationarity, spatial clusters, and tail dependence in the data. They provide useful information for guiding new climate model developments.
A Fourier analysis of extreme events

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Thomas Mikosch
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Key words: Heavy-tailed phenomena; Frequency analysis; Extreme value theory; Time series analysis.

Abstract

The extremogram is an asymptotic correlogram for extreme events constructed from a regularly varying stationary sequence. In this paper, we define a frequency domain analog of the correlogram: a periodogram generated from a suitable sequence of indicator functions of rare events. We derive basic properties of the periodogram such as the asymptotic independence at the Fourier frequencies and use this property to show that weighted versions of the periodogram are consistent estimators of a spectral density derived from the extremogram.

References

Statistics of heteroscedastic extremes

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Tilburg University, The Netherlands

Laurens de Haan
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Key words: Sequential tail empirical process; The Hill estimator; Trend diagnosis; Forecasting

Abstract

Classic extreme value statistics is usually based on assuming independently and identically distributed (i.i.d.) observations. In this paper, we develop a new set of tools in extreme value analysis that can handle observations drawn from different distributions. By assuming that the historical observations are drawn from distributions with comparable tails, we provide estimation procedure to estimate high quantiles with low tail probability at each time point in the past. In addition, we establish a testing procedure to test the null hypothesis of “no trend in extreme events”. When rejecting such a null, one may confirm the significant difference in the estimated high quantiles. Lastly, we show how to evaluate high quantiles at a time point in the future by exploiting a continuity property in the trend.
On generalized max-linear models

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Key words: max-stable process; generalized Pareto process; max-linear model; Multivariate extreme value distribution; D-norm;

Abstract

We propose a way how to generate a max-stable process in $C[0,1]$ from a max-stable random vector in $\mathbb{R}^d$ by generalizing the max-linear model established by Wang and Stoev (2011, [5]). It turns out that if the random vector follows some finite dimensional distribution of some initial max-stable process, the approximating processes converge uniformly to the original process and the pointwise mean squared error can be represented in a closed form. The obtained results carry over to the case of generalized Pareto processes. The introduced method enables the reconstruction of the initial process only from a finite set of observation points and, thus, reasonable prediction of max-stable processes gets possible (Falk et al. (2013, [3])).

References

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