Workshop on Extreme Value and Time Series Analysis

March 21 – 23, 2016

Karlsruhe, Germany

Programme

Detailed Programme

Monday, March 21, 2016

13:00 - 14:00 *Registration and Welcome Coffee*

14:00 - 14:05 Welcome Words

14:05 - 14:40 Gennady Samorodnitsky: Functional Central Limit Theorem for Heavy Tailed Stationary Infinitely Divisible Processes Generated by Conservative Flows

14:40 - 15:15 Parthanil Roy: Branching Random Walks, Stable Point Processes and Regular Variation

15:15 - 15:50 Serge Cohen: What happens to a random walk of chained particles when the chain is very long?

15:50 - 16:20 *Coffee Break*

16:20 - 16:55 Almut Veraart: Modelling multivariate serially correlated count data in continuous time

16:55 - 17:30 Mathieu Rosenbaum: The microscopic foundations of volatility statistical properties

17:30 - 18:05 Jens-Peter Kreiss:A Model Specification Test for GARCH(1,1) Processes

Tuesday, March 22, 2016

9:30 - 10:05	Peter Brockwell: CARMA Random Fields on $\mathbb{R}^n$
10:05 - 10:40	Markus Scholz: Estimation of Cointegrated MCARMA Processes
10:40 - 11:15	*Coffee Break*
11:15 - 11:50	Bikramjit Das: Risk contagion: marginal expectations under asymptotic independence
11:50 - 12:25	Christian Francq: Joint inference on market and estimation risks in dynamic portfolios
12:25 - 13:00	Paul Embrechts: Quantile-based risk sharing
13:00 - 14:15	*Lunch Break*
14:15 - 14:50	Clément Dombry: Full likelihood inference for multivariate extreme value distributions count data in continuous time
14:50 - 15:25	Johan Segers: Maximum likelihood estimation for the Fréchet distribution based on block maxima extracted from a time series
15:25 - 15:55	*Introduction to Posters*
15:55 - 17:00	*Poster Session with Coffee Break*
17:00 - 17:35	John Einmahl: A continuous updating weighted least squares estimator of tail dependence in high dimensions
17:35 - 18:15	Holger Rootzén: Multivariate peaks over thresholds modelling and likelihood inference
18:15 - open end	*Conference Dinner*

Wednesday, March 23, 2016

9:30 - 10:05 Paul Doukhan: An approach to extreme value theory without limit

10:05 - 10:40 Michael Falk: An Offspring of Multivariate Extreme Value Theory: D-Norms

10:40 - 11:15 *Coffee Break*

11:15 - 11:50 Claudia Klüppelberg: Max-linear models on graphs

11:50 - 12:25 Richard Davis: On Consistency/Inconsistency of MDL Model Selection for Piecewise Autoregression

12:25 - 13:00 Sidney Resnick: Multivariate Regular Variation of In- and Out-Degree in a Network Growth Model

13:00 - 14:00 *Lunch*

Abstracts of Talks

Peter Brockwell, Colorado State University, U.S.A.

CARMA Random Fields on $\mathbb{R}^n$

Abstract: In this talk we first define an isotropic Lévy-driven CARMA(p, q) random field on $\mathbb{R}^n$ as the integral of an isotropic CARMA kernel with respect to a Lévy sheet. Such fields constitute a parametric family characterized by an autoregressive polynomial a and a moving average polynomial b having zeros in both the left and right complex half-planes. They extend the *well-balanced Ornstein-Uhlenbeck process* of Schnurr and Woerner [3] to a well-balanced CARMA process in one dimension (with a much richer class of autocovariance functions) and to an isotropic CARMA random field on $\mathbb{R}^n$ for $n > 1$. We derive second-order properties of these random fields and find that the CAR(1) fields constitute a subclass of the well known Matérn class. We then extend the definition to include anisotropic CARMA random fields. If the driving Lévy sheet is compound Poisson it is a trivial matter to simulate the corresponding random field on any n-dimensional hypercube. A method for joint estimation of the CARMA kernel parameters and knot locations is proposed for compound-Poisson-driven fields and is illustrated by applications to simulated data and Tokyo land-price data.

This talk is based on a joint work with Yasumasa Matsuda, Tohoku University, Japan

References:

[1] L. Grafakos, G.Teschl (2013). On Fourier transfroms of radial functions and distributions. J. Fourier Anal. Appl., **19**, 167–179.

[2] D.Higdon (2002). Space and space-time modeling using process convolutions. *Quantitative Methods for Current Environmental Issues*,Clive W. Anderson, Vic Barnett, Philip C. Chatwin, Abdel H. El-Shaarawi (eds), Springer-Verlag, New York, 37–56.

[3] A.Schnurr, J.L.C. Woerner (2011). Well-balanced Lévy-driven Ornstein-Uhlenbeck processes. *Statistics and Risk Modelling*, **4**, 343–359.

Serge Cohen,Institut de Mathḿatiques de Toulouse, France

WHAT HAPPENS TO A RANDOM WALK OF CHAINED PARTICLES WHEN THE CHAIN IS VERY LONG?

Abstract: Consider a random walk of a chain of $K+1$ particles at integer sites, where the chaining keeps each particle at distance 1 from its immediate neighbors. In dimension 1, we showed with Boissard, Espinasse and Norris that the effect of chaining is to slow down the walk by a factor of $\frac{2}{(K+2)}$. In this talk I will make some remarks for the cases when K is infinite.

This talk is based on a joint work with E. Boissard, T. Espinasse and J. Norris

References:

[1] E. H. Lieb, *Residual entropy of square ice*, Physical Review **162** (1967), no. 1, 162–172.

[2] Sean Meyn and Richard L. Tweedie, *Markov chains and stochastic stability*, second ed., Cambridge University Press, Cambridge, 2009, With a prologue by Peter W. Glynn.

Bikramjit Das, Singapore University of Technology and Design

RISK CONTAGION: MARGINAL EXPECTATIONS UNDER ASYMPTOTIC INDEPENDENCE

Abstract: The issue of risk contagion concerns any entity dealing with large scale risks. Suppose $\mathbf{Z} = (Z_1, Z_2)$ denotes risk pertaining to two components in some system. A relevant measurement of risk contagion would be to quantify the amount of influence of high values of Z_2 on Z_1. In this paper, we study two such measures: the quantity $\mathbb{E}[(Z_1 - t)_+ | Z_2 > t]$ called *Marginal Mean Excess* (MME) as well as the related quantity $\mathbb{E}[Z_1 | Z_2 > t]$ called *Marginal Expected Shortfall* (MES). We work under the assumption of multivariate regular variation, hidden regular variation and asymptotic tail independence for the risk $\mathbf{Z}$. Many broad and useful model classes satisfy these assumptions. We observe that although we assume asymptotic tail independence in the models, MME and MES converge to ∞ under very general conditions; this reflects that the underlying weak dependence in the models still remains significant. Besides the consistency of the empirical estimators we introduce an extrapolation method based on extreme value theory to estimate both MME and MES for high thresholds t where little data is available. We show that these estimators are also consistent and illustrate our methodology in both simulated and real data sets.

This talk is based on a joint work with Vicky Fasen

Richard A. Davis, Columbia University, USA

On Consistency/Inconsistency of MDL Model Selection for Piecewise Autoregression

Abstract: The Auto-PARM (Automatic Piecewise AutoRegressive Modeling) procedure, developed by Davis, Lee, and Rodriguez-Yam (2006), uses the minimum description length (MDL) principle to estimate the number and locations of structural breaks in a non-stationary time series. Consistency of this model selection procedure has been established when using conditional maximum (Gaussian) likelihood variance estimates. In contrast, the estimate of the number of change-points is inconsistent in general if Yule-Walker variance estimates are used instead. This surprising result is due to an exact cancellation of first-order terms in a Taylor series expansion in the conditional maximum likelihood case, which does not occur in the Yule-Walker case.

This talk is based on a joint work with Stacey Hancock and Yi-Ching Yao.

Clément Dombry, Université de Franche Comté, France

Full likelihood inference for multivariate extreme value distributions

Abstract: Full likelihood inference methods for max-stable distributions suffer from the curse of dimension since the number of terms in the full likelihood in dimension d is equal to the Bell number B_d. For instance, $B_{10} \approx 1,16\,10^5$ and $B_{20} \approx 5,17\,10^{23}$. A direct maximisation of the likelihood is hence extremely challenging and one often uses pairwise or composite likelihood instead. The purpose of this talk is to present two on-going projects dealing with an EM approach for maximising the full likelihood and a Bayesian methodology. We introduce an additional random variable, called hitting scenario, defined as a random partition associated with the occurrence times of the maxima. Treating the hitting scenario as a missing observation, the completed likelihood becomes simpler and we can apply a EM strategy to maximise the full likelihood or a Monte-Carlo Markov Chain approach to estimate the posterior distribution. Preliminary numerical studies based on the logistic model will be presented during the talk.

This talk is based on a joint work with M.Genton, R.Huser and M.Ribatet for the EM approach, S.Egenlke and M.Oesting for the Bayesian approach.

Paul Doukhan, University Cergy-Pontoise and French universitary institute, France

An approach to extreme value theory without limit

Abstract: Extreme values theory (EVT) for time series is a tough question (addressed by the other talks of this conference, we aim at describing some simple way to avoid those difficulties. A subsampling approach is first described to consider extreme values for time series, in a paper joint with Prohl and Robert (Test, 2011). The results includes classes of non-mixing time series; recall that EVT usually requires such demanding dependence conditions. Secondly an approach through phantoms introduced in a joint paper with Jakubowski and Lang (Extremes, 2015) is also provided. This approach aims at avoiding dependence in such EVT. Under simple dependence conditions we prove that extreme values of a time series behave as those of an independent sequence. Unfortunately such phantoms also need to be identified so that our program to avoid EVT is not yet complete. Some algorithms to fit such phantoms will thus be evocated.

This talk is based on joint works with Adam Jakubowski, Gabriel Lang, Silika Prohl and Christian Robert.

References:

[1] P. Doukhan, S. Prohl, C. Y. Robert (2011) Subsampling weakly dependent time series and application to extremes. Discussion paper TEST 20-3, 447-502.

[2] P. Doukhan, A. Jakubowski, G. Lang (2015) Phantom distribution functions for some stationary sequences. Extremes 16-4, 697-725.

John H.J. Einmahl, Tilburg University, The Netherlands

A continuous updating weighted least squares estimator of tail dependence in high dimensions

Abstract: Likelihood-based procedures are a common way to estimate tail dependence parameters. They are not applicable, however, in non-differentiable models such as those arising from recent max-linear structural equation models. Moreover, they can be hard to compute in higher dimensions. An adaptive weighted least-squares procedure matching nonparametric

estimates of the stable tail dependence function with the corresponding values of a parametrically specified proposal yields a novel minimum-distance estimator. The estimator is easy to calculate and applies to a wide range of sampling schemes and tail dependence models. In large samples, it is asymptotically normal with an explicit and estimable covariance matrix. The minimum distance obtained forms the basis of a goodness-of-fit statistic whose asymptotic distribution is chi-square. Extensive Monte Carlo simulations confirm the excellent finite-sample performance of the estimator and demonstrate that it is a strong competitor to currently available methods. The estimator is then applied to disentangle sources of tail dependence in European stock markets.

Joint work with Anna Kiriliouk and Johan Segers

Paul Embrechts, ETH, Switzerland

Quantile-based risk sharing

Abstract: We address the problem of risk sharing among agents using a two-parameter class of quantile-based risk measures, the so-called Range-Value-at-Risk (RVaR), as their preferences. The family of RVaR includes the Value-at-Risk (VaR) and the Expected Shortfall (ES), the two popular and competing regulatory risk measures, as special cases. We first present an inequality for RVaR aggregation, showing that a special form of subadditivity is satisfied by RVaR. Then, the risk sharing problem is solved by explicit construction. Three relevant issues in the optimal allocations are investigated: extra sources of randomness, comonotonicty, and model uncertainty. We show that in general, a robust optimal allocation exists if and only if none of the underlying risk measures is a VaR. Practical implications of the main results for risk management and policy makers are discussed, including gambling behaviour, moral hazard, regulatory arbitrage, and model misspecification. In particular, in the context of regulatory capital reduction, we provide some general guidelines on how a regulatory risk measure can lead to certain desirable or undesirable properties of risk sharing among firms, and show novel advantages of ES from the perspective of a regulator.

This talk is based on joint work with Hailyan Liu and Ruodu Wang (University of Waterloo)

Michael Falk, University of Wuerzburg, Germany

An Offspring of Multivariate Extreme Value Theory: D-Norms

Abstract: Multivariate extreme value theory (MEVT) is the proper toolbox for analyzing several extremal events simultaneously. Its practical relevance in particular for risk assessment is, consequently, obvious. But on the other hand MEVT is by no means easy to access; its key results are formulated in a measure theoretic setup, a fils rouge is not visible.

Writing the 'angular measure' in MEVT in terms of a random vector, however, provides the missing fils rouge: Every result in MEVT, every relevant probability distribution, be it a max-stable one or a generalized Pareto distribution, every relevant copula, every tail dependence coefficient etc. can be formulated using a particular kind of norm on multivariate Euclidean space, called D-norm. Norms are introduced in each course on mathematics as soon as the multivariate Euclidean space is introduced. The definition of an arbitrary D-norm requires only the additional knowledge on random variables and their expectations. But D-norms do not only constitute the fils rouge through MEVT, they are of mathematical interest of their own.

This talk provides a relaxed tour through essentials of MEVT, due to the D-norms approach. Quite recent results on multivariate records complete the talk.

This talk is partially based on joint work with Clément Dombry and Maximilian Zott.

References:

[1] M. Falk (2015). An offspring of multivariate extreme value theory: D-norms. `www.statistik-mathematik.uni-wuerzburg.de/fileadmin/10040800/D-norms-tutorial_book.pdf`

Christian Francq, CREST, France

Joint inference on market and estimation risks in dynamic portfolios

Abstract: We study the estimation risk induced by univariate and multivariate methods for evaluating the conditional Value-at-Risk (VaR) of a portfolio of assets. The composition of the portfolio can be time-varying and the individual returns are assumed to follow a general multivariate dynamic model. Under sphericity of the innovations distribution, we introduce in the multivariate framework a concept of VaR parameter, and we establish the asymptotic distribution of its estimator. A multivariate Filtered Historical Simulation method,

which does not rely on sphericity, is also studied. We derive asymptotic confidence intervals for the conditional VaR, which allow to quantify simultaneously the market and estimation risks. The particular case of minimal variance and minimal VaR portfolios is considered. Potential usefulness, feasibility and drawbacks of the different approaches are illustrated via Monte-Carlo experiments and an empirical study based on stock returns.

This talk is based on a joint work with Jean-Michel Zakoian

Claudia Klüppelberg, Technische Universität München, Germany

Max-linear models on graphs

Abstract: We consider a new structural equation model, where all random variables can be written as a max-linear function of their parents and independent noise terms. We assume that the dependence structure of the corresponding vector can be modeled by a directed acyclic graph. We show that the multivariate distribution is max-linear and characterize all max-linear models, which are generated by a structural equation model. We detail the relation between the coefficients of the structural equation model and the max-linear coefficients. Furthermore, we derive minimal representations of our model and investigate certain subgraphs arising from order between (or equality of) different components of the vector.

This talk is based on joint work with Nadine Gissibl

References:

[1] N. Gissibl and C. Klüppelberg (2015) Max-linear models on directed acyclic graphs.

[2] N. Gissibl, and C. Klüppelberg (2015) Max-stable DAGs. In preparation.

Jens-Peter Kreiss, Technische Universität Braunschweig, Germany

A Model Specification Test for GARCH(1,1) Processes

Abstract: We provide a consistent specification test for generalized autoregressive conditional heteroscedastic (GARCH(1,1)) models based on a test statistic of Cramér-von Mises type. Because the limit distribution of the test statistic under the null hypothesis depends

on unknown quantities in a complicated manner, we propose a model-based (semiparametric) bootstrap method to approximate critical values of the test and to verify its asymptotic validity. Finally, we illuminate the finite sample behaviour of the test by some simulations.

This talk is based on joint work with Anne Leucht and Michael Neumann

References:

[1] Berkes, Horváth and Kokoska (2004). A weighted goodness-of-fit test for GARCH(1,1) specification. Lithuanian Mathematical Journal, **44**, 3–22.

[2] Escanciano (2007). Goodness-of-fit tests based on kernel density estimators with fixed smoothing parameters. Statistica Sinica, **17**, 115–138.

[3] Escanciano (2008). Joint and marginal specification tests for conditional mean and variance models. Journal of Econometrics, **143**, 74–87.

[4] Fan and Li (2000). Consistent model specification tests: kernel-based tests versus BierensÕ ICM tests. Econometric Theory, **16**, 1016–1041.

[5] Francq and Zakoïan (2004). Maximum likelihood estimation of pure GARCH and ARMA-GARCH processes. Bernoulli, **10**, 605–637.

[6] Leucht and Neumann (2013). Degenerate U- and V-statistics under ergodicity: Asymptotics, bootstrap and applications in statistics. Annals of the Institute of Statistical Mathematics, **65**, 349–386.

[7] Leucht, K. and Neumann (2015). A model specification test for GARCH(1,1) processes. Scandinavian Journal of Statistics, **42**, 1167–1193.

Sidney Resnick, Cornell University, Ithaca, NY 14850 USA

Multivariate Regular Variation of In- and Out-Degree in a Network Growth Model

Abstract: For the directed edge preferential attachment network growth model studied by Bollobás et al. (2003) and Krapivsky and Redner (2001), we prove that the joint distribution of in-degree and out-degree is jointly regularly varying. Typically the marginal tails of the in-degree distribution and the out-degree distribution have different regular variation indices

and so the joint regular variation is non-standard. We discuss direct analysis of the measures, analysis by Tauberian theory and analysis using the probability mass function.

This talk is based on a joint work with G. Samorodnitsky, D. Towsley, R. Davis, A. Willis, P. Wan. T. Wang.

References:

[1] B. Bollobás, C. Borgs, J. Chayes and O. Riordan (2003). Directed scale-free graphs. In Proceedings of the Fourteenth Annual ACM-SIAM Symposium on Discrete Algorithms (Baltimore, 2003). ACM, New York, 132–139.

[2] P. Krapivsky and S. Redner (2001). Organization of growing random networks. Physical Review **E 63:066123**, 1–14.

[3] G. Samorodnitsky, S. Resnick, D. Towsley, R. Davis, A. Willis,P. Wan, (2016). Non-standard regular variation of in-degree and out-degree in the preferential attachment model, Journal of Applied Probability, 53(1), `http://arxiv.org/pdf/1405.4882.pdf`.

[4] S. Resnick, G. Samorodnitsky (2015). Tauberian Theory for Multivariate Regularly Varying Distributions with Application to Preferential Attachment Networks. Extremes, **18(3)**, 349–367.

[5] T. Wang, S. Resnick (2016). Multivariate Regular Variation of Discrete Mass Functions with Applications to Preferential Attachment Networks. `https://arxiv.org/submit/1451036`.

Holger Rootzén, Chalmers, Sweden

MULTIVARIATE PEAKS OVER THRESHOLDS MODELLING AND LIKELIHOOD INFERENCE

Abstract: Natural catastrophes and fluctuations in financial markets are significant societal and economic problems. This talk reviews ongoing work on Multivariate Peaks over Thresholds modeling aimed at handling a broad spectrum of risks. Multivariate Generalized Pareto distributions - a still rather unexplored territory - is used as the main modelling tool. I will discuss a general model for extreme episodes in data, and show how conditioning the distribution of extreme episodes on threshold exceedance gives three basic representations of the family of Generalized Pareto distributions. Numerically tractable forms of densities

and censored densities are derived, and give tools for flexible parametric likelihood inference, and a number of simulation algorithms are constructed. As one of many uses of the model, prediction of extreme influenza epidemics is discussed.

Joint work with Anna Kiriliouk, Johan Segers, Maud Thomas, Jennifer Wadsworth

References:

[1] H. Rootzén, J. Segers and J. Wadsworth (2016). Multivariate Peaks over Thresholds models. ArXive.

[2] A. Kiriliouk, H. Rootzén, J. Segers and J. Wadsworth (2016). Peaks over thresholds modelling with multivariate generalized Pareto distributions. Working paper,

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Mathieu Rosenbaum, University Marie and Pierre Curie (Paris 6), France

THE MICROSCOPIC FOUNDATIONS OF VOLATILITY STATISTICAL PROPERTIES

Abstract: In this talk, we will first review a series of statistical stylized facts of the volatility process typically encountered in financial data. We will in particular focus on the rough nature of the volatility, its persistence properties, and on the so-called leverage effect. In the second part of the talk, we will show how such features can be explained from a microscopic point of view. More precisely, we will introduce specific point processes (Hawkes processes) enabling us to model accurately the agents behaviour on financial markets at the high frequency scale. Then we will demonstrate that the volatility arising from the long term dynamics of such point processes enjoys the properties detailed in the first part of the talk.

This talk is based on a joint work with Omar El Euch and Thibault Jaisson

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Parthanil Roy, Indian Statistical Institute, Kolkata, India

BRANCHING RANDOM WALKS, STABLE POINT PROCESSES AND REGULAR VARIATION

Abstract: Using the language of regular variation, we give a sufficient condition for a point process to be in the superposition domain of attraction of a strictly stable point process. This

sufficient condition is then used to obtain the weak limit of a sequence of point processes induced by a branching random walk with jointly regularly varying displacements. Because of heavy tails of the step size distribution, we can invoke a one large jump principle at the level of point processes to give an explicit representation of the limiting point process. As a consequence, we extend the main result of Durrett (1983) [1] and verify that two related predictions of Brunet and Derrida (2011) [2] remain valid for this model.

This talk is based on a joint work with Ayan Bhattacharya and Rajat Subhra Hazra.

References:

[1] R. Durrett (1983). Maxima of branching random walks. Z. Wahrsch. Verw. Gebiete, **62**, No. 2, 165–170.

[2] E. Brunet, B. Derrida (2011). A branching random walk seen from the tip. J. Stat. Phys., **143**, No. 3, 420–446.

Gennady Samorodnitsky, Cornell University and Columbia University, USA

Functional Central Limit Theorem for Heavy Tailed Stationary Infinitely Divisible Processes Generated by Conservative Flows

Abstract: We establish a functional central limit theorems for partial sum of certain symmetric stationary infinitely divisible processes with regularly varying Levy measures. The limit process is a new class of symmetric stable self-similar processes with stationary increments. The normalizing sequence and the limiting process are determined by the ergodic theoretical properties of the flow underlying the integral representation of the process, most importantly by its pointwise dual ergodicity. These properties can be interpreted as determining how long is the memory of the stationary infinitely divisible process. The nature of the limits is very different in the case of positive memory and in the case of negative memory.

This talk is based on a joint work with Paul Jung and Takashi Owada

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Markus Scholz, Karlsruhe Institute of Technology, Germany

Estimation of Cointegrated MCARMA Processes

Abstract: We extend in this talk the cointegrated discrete-time model, which was introduced by Engle and Granger, to a continuous-time setting using cointegrated multivariate continuous-time autoregressive moving average (MCARMA) processes. The concept of cointegration describes the phenomena, that two or more non-stationary processes, which are integrated, can have stationary linear combinations. Cointegration models therefore stochastic trends of some or all the variables. There is empirical evidence that cointegration arises e.g. in financial data. For example exchange rates or the relation between long-term and short-term interest rates show such a common stochastic behaviour.
A question that imposes itself in this framework is how to estimate the parameters of the cointegrated MCARMA model from discrete-time observations. Since the necessary uniform convergence results do not hold for the sum of squares function, we will use a stepwise approach. For this reason, we separate the parameter vector into two vectors, where the parameters in the first vector model the cointegration space and the parameters in the second vector model the stationary part. To this end, we show super-consistency for the estimator of the cointegration parameters. In the next step, we are able to deduce the consistency for the estimator of the stationary parameters with the knowledge of the cointegration parameters. Finally, we will derive the limiting distributions of the estimators.

This talk is based on a joint work with Vicky Fasen

References:

[1] Saikkonen, P. (1993). Continuous weak convergence and stochastic equicontinuity results for integrated processes with an application to the estimation of a regression model, Econometric Theory, **9**, 155–188.

[2] Saikkonen, P. (1995). Problems with the asymptotic theory of maximum likelihood estimation in integrated and cointegrated systems. Econometric Theory, **11**, 888–911.

[3] Schlemm, E. and Stelzer, R. (2012). Quasi maximum likelihood estimation for strongly mixing state space models and multivariate Lévy-driven CARMA processes. Electronic Journal of Statistics, **6**, 2185–2234.

Johan Segers, Université catholique de Louvain, Belgium

Maximum likelihood estimation for the Fréchet distribution based on block maxima extracted from a time series

Abstract: The block maxima method in extreme-value analysis proceeds by fitting an extreme-value distribution to a sample of block maxima extracted from an observed stretch of a time series. The method is usually validated under two simplifying assumptions: the block maxima should be distributed according to an extreme-value distribution and the sample of block maxima should be independent. Both assumptions are only approximately true.

For general triangular arrays of block maxima attracted to the Fréchet distribution, consistency and asymptotic normality is established for the maximum likelihood estimator of the parameters of the limiting Fréchet distribution. The results are specialized to the setting of block maxima extracted from a strictly stationary time series. The case where the underlying random variables are independent and identically distributed is further worked out in detail. The results are illustrated by theoretical examples and Monte Carlo simulations.

This talk is based on a joint work with Axel Bücher, Technische Universität Dortmund

References:

[1] A. Bücher, J. Segers (2015). Maximum likelihood estimation for the Fréchet distribution based on block maxima extracted from a time series, arXiv:1511.07613.

[2] Dombry, C. (2015). Existence and consistency of the maximum likelihood estimators for the extreme value index within the block maxima framework. Bernoulli, **21**, 420–436.

Almut Veraart, Imperial College London, UK

Modelling multivariate serially correlated count data in continuous time

Abstract: A new continuous-time framework for modelling serially correlated count and integer-valued data is introduced in a multivariate setting. The main modelling component is a multivariate integer-valued trawl process which is obtained by kernel smoothing of an integer-valued Lévy basis. The key feature making trawl processes highly suitable for applications is the fact that their marginal distribution and their serial dependence can be modelled independently of each other. We demonstrate the flexibility of this new modelling paradigm,

by presenting various ways of describing both serial and cross-sectional dependence. Moreover, we develop efficient methods for statistical inference and model selection within the trawl framework. These methods have been tested in detailed simulation studies and their finite sample performance turns out to be very good. Finally, we apply the new methodology to high frequency financial data.

Abstracts of Posters

Dirk-Philip Brandes, Ulm University, Germany

CARMA-Processes with Lévy Autoregressive Coefficients

Abstract: Autoregressive moving average processes in continuous time (CARMA(p,q)), where $q < p$ are integers, have been point of focus for researchers in applied stochastic over the last fifteen years. As a continuous time analogue of ARMA-processes they have a wide field of applications in physics, biology and finance.
Using recent results by Behme and Lindner on multivariate generalized Ornstein-Uhlenbeck processes (MGOU), we are going to define random coefficient CARMA-processes (RC-CARMA(p,q)) as a special case. The latter generalizes CARMA-processes by adding randomness to the autoregressive part, namely by choosing not necessarily independent or uncorrelated Lévy processes. We give sufficient conditions for a strictly stationary solution to exist and compute the autocovariance and autocorrelation function. Further, by giving a full characterization of RC-CARMA(2,1)-processes, it is possible to derive necessary conditions for the existence of strictly stationary solutions in this case.

Maximilian Christ, Blue Yonder GmbH, Karlsruhe, Germany

Time series analysis in industrial applications

Abstract: This poster is about the challenges in time series analysis in industrial applications in general and in the research project iPRODICT in particular. iPRODICT explores the automation of industrial manufacturing environments by supporting and controlling the production of steel billets at a German steel manufacturer. It is funded by the German Federal Ministry for Education (BMBF).

Two topics that involve time series analysis are frequently occurring within Blue Yonder's projects in the industrial market. Those are predictive maintenance *[1]* and quality forecast in discrete and continuous manufacturing *[2]*. The iPRODICT research project tackles the latter case, quality forecasts in semi-discrete production, where both time series data and univariate variables are given.

In industrial applications such as iPRODICT several several interesting issues arise, all having the potential for further research:

1. Automated feature selection from time series
2. Modeling of SCADA time series containing MAX, MIN, $MEAN$, SD values of sensor measurements aggregated over fixed time intervals *[3]*
3. Assigning of time series intervals to (produced) units
4. Statistical modeling of both univariate variables and time series

All those topics occur in many other industrial applications as well which is why solving them will not only help the iPRODICT project but also provide real benefit to industrial predictive applications in general.
References:

[1] G. A. Susto, A. Schirru, S. Pampuri, S. McLoone, and A. Beghi (2015). Machine Learning for Predictive Maintenance: A Multiple Classifier Approach. Transactions on Industrial Informatics, **11**, No. 2, 812–820.

[2] K. Hansson, S. Yella, M. Dougherty, and H. Fleyeh (2016). Machine Learning Algorithms in Heavy Process Manufacturing. American Journal of Intelligent Systems, **6**, 1–13.

[3] M. Schlechtingen, I. F. Santos, and S. Achiche (2013). Wind turbine condition monitoring based on SCADA data using normal behavior models. Part 1: System description. Applied Soft Computing, **13**, 259–270.

Sebastian Kimmig, Karlsruhe Institute of Technology, Germany

Robust estimation of continuous–time ARMA processes

Abstract: Continuous–time ARMA(p,q) (CARMA(p,q)) processes are the continuous–time analog of the discrete–time ARMA processes. There exist a few approaches to estimate the model parameters of a CARMA process consistently as, e.g., quasi–maximum–likelihood estimation in [3] and [1]. However, the estimators in the present literature do not work when the data contains outliers. Therefore, robust estimators of the CARMA parameters, which are able to deal with different types of outliers in the data, are necessary.
It is well–known that generalized M–estimators are robust estimators for AR processes, but in general not for ARMA processes. Instead, [2] propose an indirect estimation procedure. We use a similar ansatz for estimating CARMA processes robustly.

First, we approximate the discretely observed CARMA(p,q) process by an auxiliary AR(m) representation, $m > 2p - 1$. The parameters of this AR(m) process are estimated by a generalized M–estimator. Due to identifiability, there exists a unique, injective map linking the parameters of the AR(m) process to the parameters of the underlying CARMA(p,q) process. Unfortunately, an analytic representation of this map does not exist. To overcome this we have to estimate this map by an additional simulation study. Finally, coupling both estimators gives a robust estimator for the CARMA process. We present the asymptotic behavior as well as the quantifiable robustness properties of this estimator.

This poster is based on joint work with Vicky Fasen.

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Moving Average Sieve Bootstrap

Abstract: For nondeterministic stationary processes with spectral densities, Szegö's factorization of the spectral density can be used to get a moving average (MA) representation of the spectral density, similar to the Wold decomposition. We use these MA coefficients to generate a Wild MA Sieve Bootstrap, which is able to mimic the second order structure of the underlying process. If the underlying process is linear, the MA Sieve Bootstrap is able to mimic to the necessary extent the fourth order moment structure, which occurs in statistics like the empirical autocovariance. We proof that the proposed bootstrap procedure asymptotically works for the mean and a general class of statistics, which contains the empirical autocovariance and autocorrelation, among others. Furthermore, we compare it to the linear process bootstrap and the AR-Sieve bootstrap. Its finite sample performance is investigated by means of simulations.

This talk is based on a joint work with Jens-Peter Kreiss and Efstathios Paparoditis

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THE POLAR EXTREME VALUE MODEL: A GEOMETRICAL ANALYSIS.

Abstract: To study the asymptotics of random vectors (X, Y), Heffernan and Resnick (2007) proposed the conditional extreme value (CEV) approach. The aim is to find the limiting conditional distribution of (X, Y) as the conditioning variable X becomes large. In this context, the elliptical distributions have been intensively investigated. Fougères and Soulier (2010) extended these class of distributions to those with a polar representation $R \cdot (u(T), v(T))$ where R, T are stochastically independent and convex level curves $(u(t), v(t))$ and derived a conditional limit statement for (X, Y). We present further interesting generalizations of the existing conditional limit theorems into different directions:

1. the level curves $(u(t), v(t))$ are allowed to be quite arbitrary, they might be non-convex forming *cusps*,
2. the stochastic independence assumption on the polar components R and T is weakened.

For the first generalization we show that a non-degenerate limit statement can be obtained only after *random norming* (cf. Heffernan and Resnick 2007). For the second generalization, we propose a novel geometric measure for the dependence structure and present convenient criteria for validity of limit theorems. We put a special emphasize on geometrical analysis of the assumptions and results and elucidate them by several figures.

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Measuring and Combining Different Aspects of Goodness of Fit of Dynamical Extreme Value Models in Hydrology

Abstract: We study four different approaches to model time-dependent extremal behavior: dynamics introduced by (a) a state-space model (SSM), (b) a shot-noise-type process with GPD marginals, (c) a copula-based autoregressive model with GPD marginals, and (d) a GLM with GPD marginals (and previous extremal events as regressors).

Each of the models is fit against data, and from the fitted data, we simulate corresponding paths according to the respective fitted models. At this simulated data, the respective dependence structure is analyzed in copula plots and judged against its capacity to fit the corresponding inter-arrival distribution.

Additionally, this presentation assesses the goodness of fit (GoF) of these modeling approaches in a quantitative way, and focusses on the following aspects separately: GoF for the (one-dimensional) marginals, for the induced interarrival time distribution of subsequent exceedances of a high threshold, for the bivariate copula of two subsequent observations to capture the general one-step dependence structure, and a weighted version of the latter, focussing on the tail dependence structure for extremely large observations.

Each of these four GoF measures may be used at its own right, but at the same time, can also either be combined to give a (weighted) overall GoF measure or can be treated like a multiple test, judged against the family-wise error rate.

We present simulation based critical values for the respective tests as well as first asymptotic distributional results, and report the respective results when applied to hydrological data from a gauge at Donauwoerth.

This talk is based on a joint work with Peter Ruckdeschel (Oldenburg University), Sascha Desmettre (Kaiserslautern University), and Andreas Mändle (Oldenburg University).
