Programme

All lecture halls (auditoriums) are located in the HCO (H. Orsted Institute) of the University of Copenhagen. The titles and abstracts of the 30 minute talks are given below.

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Monday, 20 October
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Gennady Samorodnitsky's topics of the lectures:
Introduction. Hurst phenomenon. Long memory and non-stationarity.
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Auditorium 8
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09:30-10:15 Registration (in front of lecture hall)
10:15-10:30 Opening
10:30-12:00 Lecture I
12:00-14:00 Lunch break
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Auditorium 10
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14:00-15:30 Lecture II
15:30-16:00 Coffee break
16:00-16:30 Talk Muneya Matsui (Keio)
16:30-17:00 Talk Martin Wendler (Bochum)
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Tuesday, 21 October
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Gennady Samorodnitsky's topics of the lectures:
Long memory and ergodic theory. Strong mixing. 2nd order
notions of long range dependence.
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Auditorium 5
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09:00-10:30 Lecture III
10:30-11:00 Coffee break
11:00-11:30 Talk Dimitrij Celov (Vilnius)
11:30-12:00 Talk Dainius Dzindzalieta (Vilnius/Copenhagen)
12:00-14:00 Lunch break
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Auditorium 5
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14:00-15:30 Lecture IV
15:30-16:00 Coffee break
16:00-16:45 Talk Olivier Wintenberger (Paris)
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Wednesday, 22 October
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Gennady Samorodnitsky's topics of the lectures:
Fractional models. Self-similar processes (part I).
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Auditorium 10
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09:00-10:30 Lecture V
10:30-11:00 Coffee break
11:00-11:20 Talk Peter Parczewski (TU Braunschweig)
11:20-12:00 Talk Catalin Starica (Chalmers Gothenburg)
12:00-14:00 Lunch break
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Auditorium 10
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14:00-14:45 Lecture VIa
14:45-15:15 Coffee break
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Auditorium 5
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15:15-16:00  Lecture VIb
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Thursday, 23 October
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Gennady Samorodnitsky's topics of the lectures:
Self-similar processes (part II). Long memory and phase transitions.
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Auditorium 5
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09:00-10:30 Lecture VII
10:30-11:00 Coffee break
11:00-12:00 Talk Thomas Mikosch
12:00-14:00 Lunch break
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Auditorium 5
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14:00-15:30 Lecture VIII
15:30-16:00 Coffe break
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Abstracts of Talks and Posters

On stationary solutions of not necessarily causal generalized Ornstein-Uhlenbeck processes (Poster)

Anita Behme (TU Braunschweig)

The generalized Ornstein-Uhlenbeck process V is defined as

$$V_t = e^{-\xi_t}\left(V_0 + \int_0^t e^{\xi_{s-}}\,d\eta_s\right), t \geq 0$$

where $(\xi_t, \eta_t)_{t\geq 0}$ is a bivariate Lévy process. In the causal case V_0 is an independent starting random variable. The stationarity of this process has already been studied in detail. Our aim is now to analyze the Ornstein-Uhlenbeck process with a not necessarily independent V_0. As in the causal case stationarity is mainly affected by the convergence of the integral $\int_0^\infty e^{-\xi_{t-}}\,d\eta_t$. We specify the occurring differences and explore the stationary solutions.

Disaggregation of long memory processes in AR(1) aggregation scheme

Dmitrij Celov (Vilnius)

The main objective of the presentation is devoted to the statistical properties of a mixture density estimator in autoregression of the first order (AR(1)) (dis)aggregation scheme which may lead to the long memory phenomenon and its empirical applications in economics. The presentation covers relevant problems regarding large-scale time series aggregation and disaggregation problems, in particularly AR(1) model is emphasized. The scientific research aimed to study in more details the statistical properties of suggested in Leipus et al. (2006) disaggregation estimator (LOPV) for the mixture density of AR(1) individual processes with random autoregression parameter. The estimator is based on the expansion of the density function on the basis of orthogonal Gegenbauer polynomials. Besides that, the work verifies the robustness of LOPV estimator to the violation of key aggregation assumptions, compares it to the alternative approaches, and shows connections to the long memory topic. According to the preliminary simulation results, a more robust extension of LOPV estimator has been suggested. The assumptions for asymptotic normality of LOPV estimator are investigated. Theoretic results are checked by the means of Monte-Carlo simulations. Finally, an application to G7 aggregated consumption data is investigated.

Exact bounds for tail probabilities and bounds for stop-loss premium of martingales (25 min)

Dainius Dzindzalieta (Vilnius)

We consider conditionally symmetric martingales and derive exact upper bounds for their tail probabilities. We extend Hoeffding type bounds to unbounded random variables and apply the results to a stop-loss premium.

Classes of infinitely divisible distributions on $\mathbb{R}^d$ related to the class of self-decomposable distributions

Muneya Matsui (Keio University)

We study several new classes of infinitely divisible distributions on $\mathbb{R}^d$.

(1) The connecting classes with a continuous parameter between the Jurek class and the class of self-decomposable distributions are revisited.
(2) The range of the parameter is extended to construct new classes and characterizations in terms of stochastic integrals with respect to Lévy processes.
(3) The nested subclasses of these classes are discussed and characterized in two ways: by stochastic integral representations and in terms of Lévy measures.

This is joint work with Makoto Maejima and Mayo Suzuki.

The extremogram: a correlogram for extreme events

Thomas Mikosch (Copenhagen)

This is joint work with Richard A. Davis (Columbia).

The motivation for this research comes from the problem of choosing between two popular and commonly used families of models, the generalized autoregressive conditional heteroscedastic (GARCH) process and the heavy-tailed stochastic volatility (SV) process, for modeling a particular financial time series. Both the GARCH and SV models possess the *stylized features* exhibited by log-returns of financial assets. Specifically, these time series have heavy-tailed marginal distributions, are dependent but uncorrelated, and display stochastic volatility. The latter property is manifested via the often slow decay of the sample autocorrelation function (ACF) of the absolute values and squares of the time series. Since both GARCH and SV models can be chosen to have virtually identical behavior in the tails of the marginal distribution and in the ACF of the squares of the process, it is difficult for a given time series of returns to decide between the two models on the basis of routine time series diagnostic tools.

The asymptotic behavior of the extremes leads to one clear difference between GARCH and SV processes. It was shown in previous work by the authors that GARCH processes exhibit extremal clustering (i.e., clustering of extremes), while SV processes lack this form of clustering. Associated with most stationary time series is a parameter $\theta \in (0,1]$, called the extremal index, which is a measure of the clustering of extremes. For GARCH processes $\theta < 1$ (clustering) and for SV processes $\theta = 1$ (no clustering). The parameter θ, which can be interpreted as the reciprocal of the expected cluster size in the limiting compound Poisson process of the weakly converging point processes of exceedances of (X_t), turns out to be a difficult quantity to estimate for theses processes.

We focus on strictly stationary sequences whose finite-dimensional distributions (fidis) have power law tails in some generalized sense. In particular, we will assume that the fidis of the d-dimensional process $(\mathbf{X}_t)$ have regularly varying distributions with a positive tail index α. This means that for any $h \geq 1$ the lagged vector $\mathbf{Y}_h = \text{vec}(\mathbf{X}_1, \ldots, \mathbf{X}_h)$ satisfies the relation

$$\frac{P(x^{-1}\mathbf{Y}_h \in \cdot)}{P(|\mathbf{Y}_h| > x)} \xrightarrow{v} \mu_h(\cdot)\,,$$

for some non-null Radon measure μ_h on $\mathbb{R}^{hd}\backslash\{\mathbf{0}\}$ with the property that $\mu_h(tC) = t^{-\alpha}\mu_h(C)$, $t > 0$, for any Borel set $C \subset \mathbb{R}^{hd}\backslash\{\mathbf{0}\}$. We call such a sequence $(\mathbf{X}_t)$ *regularly varying with index* $\alpha > 0$. Various time series models of interest are regularly varying. Those include infinite variance stable processes, ARMA-processes with iid regularly varying noise, GARCH processes with iid noise with infinite support (including normally and student distributed noise), SV models with iid regularly varying noise.

As a starting point for the definition of a measure of extremal dependence in a strictly stationary sequence we consider the (upper) *tail dependence coefficient*. It is defined for a two-dimensional vector (X, Y) with $X \stackrel{d}{=} Y$ as the limit (provided it exists) $\lambda(X, Y) = \lim_{x\to\infty} P(X > x \mid Y > x)$. Of course, $\lambda \in [0, 1]$, and $\lambda = 1$ when X and Y are independent or asymptotically independent. The larger λ, the larger the extremal dependence in the vector (X, Y).

The tail dependence coefficient can also be applied to the pairs (X_0, X_h) of a one-dimensional strictly stationary time series. The collection of values $\lambda(X_0, X_h)$ contains useful information about the serial extremal dependence in the sequence (X_t). If one considers a regularly varying sequence (X_t) with index $\alpha > 0$, the definition of regular variation immediately ensures the existence of the quantities $\lambda(X_0, X_h)$.

Now let $(\mathbf{X}_t)$ be a strictly stationary regularly varying sequence of $\mathbb{R}^d$-valued random vectors. Consider two Borel sets A, B in $\mathbb{R}^d$ such that $C = A\times\mathbb{R}^{d(h-1)}\times B$ is bounded away from zero and $\nu_{h+1}(\partial C) = 0$. If both A and B are bounded away from zero,

$$
\begin{aligned}
& n\,\mathrm{cov}(I_{\{a_n^{-1}\mathbf{X}_0\in A\}}\,, I_{\{a_n^{-1}\mathbf{X}_h\in B\}}) \\
&= \; n\,[P(a_n^{-1}\mathbf{X}_0 \in A\,, a_n^{-1}\mathbf{X}_h \in B) - P(a_n^{-1}\mathbf{X} \in A)\,P(a_n^{-1}\mathbf{X} \in B)] \\
&\sim \; n\,P(a_n^{-1}\mathbf{X}_0 \in A\,, a_n^{-1}\mathbf{X}_h \in B) \sim \gamma_{AB}(h)\,.
\end{aligned}
$$

We call the right hand limit *extremogram* and its empirical estimator the *sample extremogram.* We calculate the extremogram for examples (GARCH, SV,. . .) and touch on the asymptotic properties of the sample extremogram.

Approximating the Wick exponential of the fractional Brownian motion (20 min)

Peter Parczewski

The Wick-Itô integral with respect to fractional Brownian motion (fBM) is based on Wick products instead of ordinary multiplication. Sottinen showed a Donsker-type approximation of the fBM by disturbed random walks. We apply discrete Wick calculus on these discrete random variables. Thus we show weak convergence to the Wick powers of the fBM. This leads to an approximation of the Wick exponential of the fBM.

The stock markets of Europe: globalization or European integration

Cătălin Stărică (Chalmers University Gothenburg)

A non-stationary analysis of the evolution of the relationship between various levels of aggregation of returns (sectorial, national, continental and international) of the major European financial markets during the last three decades is performed. The aggregated returns are modeled as independent vectors with a time-changing unconditional covariance structure. The methodological frame is that of non-parametric regression with non-random, equidistant design points, where the regression function is the evolving unconditional covariance matrix. The modeling choice reflects our assumption of the existence of four independent factors (an international, an European, a specific national and a specific sectorial factor) that drive the dynamics of the multivariate vector of aggregated returns.

The time-changing proportions of the variance of sectorial returns explained by the national, the European and the international factors reflect the evolution of the market relations and are used to evaluate the integration process possibly at work inside the European economic space.

We find that in all the financial markets we analyzed, the proportion of the sectorial variance explained by the national factor decreased in the last 10-15 years. We also find that this decrease has been matched by an increase in the proportion explained by the international factor. Differences in the amplitude of this movements can be noticed in different markets. We do not find evidence for an increase in the co-movements of the financial indexes at European level.

Block Bootstrap for U-Statistics of Mixing Data

Martin Wendler (Bochum)

The bootstrap is a nonparametric method of statistical inference, but ordinary bootstrap does not work under dependence. Politis and Romano [2] proposed the circular block bootstrap: Blocks of observations are resampled instead of single observations. The validity of this bootstrapping method has been proved under strong mixing [3].

In the talk, we will investigate the bootstrap for non-degenerate U-statistics. In the case of iid observations, Bickel and Freedman [1] established the validity of Efron's bootstrap for U-statistics. We will extend this result to the block bootstrap for U-statistics of dependent data. Our proof uses techniques developed by Yoshihara [4] in his proof of the central limit theorem for U-Statistics of stationary, absolutely regular observations.

References

[1] Bickel and Freedman (1981): Some asymptotic theory for the bootstrap, *Ann. Stat.* **9**, 1196-1217

[2] Politis and Romano (1992) A circular block resampling procedure for stationary data, In *Exploring the Limits of Bootstrap* (R. Lepage and L. Billard, eds.) 263-270, Wiley, New York

[3] Shao and Yu (1993): Bootstrapping the sample means for stationary mixing sequences, *Stochastic Process. Appl.* **48**, 175-190

[4] Yoshihara, K. (1976): Limiting Behavior of U-Statistics for Stationary, Absolutely Regular Processes, *Z. Wahrsch. verw. Gebiete* **35**, 237-252

Randomized predictors for weakly dependent time series

Olivier Wintenberger (Paris Dauphine)

Observing a time series, we construct randomized one-step predictors for different arbitrarily chosen autoregressive models. We then choose an efficient predictor either by model selection or apply another randomization step. With the help of

PAC-Bayesian methods, we prove the efficiency of this predictor through oracle inequalities for the L^1 loss. We work under weak dependence-type assumptions whcih are satisfied when the observed time series is the stationary solution of some classical models.

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