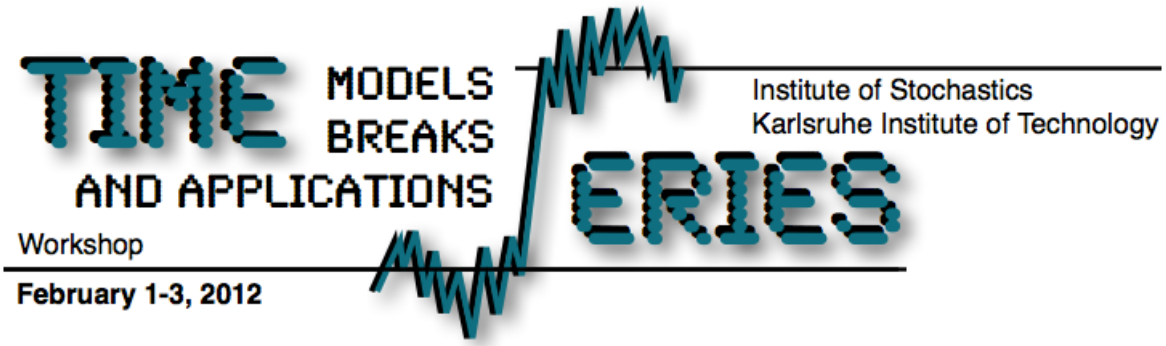

Abstracts

Wednesday:

16.00 - 17.15 Chair: Claudia Kirch

Detecting changes in the drift via invariance

Allan Gut, Josef Steinebach and Hella Timmermann

We present some recent results about sequential monitoring procedures, which have been constructed for detecting an "abrupt" or "gradual" change in the drift parameter of a general stochastic process. We assume that the latter process, e.g., a renewal counting process, has been observed in discrete time and that it satisfies a certain (weak) invariance principle (with rate). It is shown that the tests can be constructed such that the "false alarm rate" attains a prescribed level (say) α and that the tests have "asymptotic power 1". A more precice analysis of the procedures under the alternative proves that the stopping times, suitably normalized, have a standard normal limiting distribution. A few results from a small simulation study are also presented in order to give an idea of the finite sample behaviour of the suggested procedures.

Sequential monitoring and change detection

Edit Gombay

We consider new sequential monitoring strategies, and compare them to open ended strategies. Their advantages are demonstrated, and some examples from applications are presented. These include multi-armed longitudinal clinical trials, monitoring surgical performance, and time series type data. The methods are simple and relatively easy to apply. Their theoretical background relies on stochastic processes that can be approximated by Brownian motions. One can describe these monitoring procedures as the continuous time versions of the well-known Pocock and O'Brien-Fleming group sequential procedures.

17.30 - 18.30 Chair: Herold Dehling

Power analysis and projections in functional change point analysis with applications to fMRI

John Aston and Claudia Kirch

Functional Brain Imaging modalities provide ways to examine the brain in-vivo. The data sets consist of dense spatial and temporal information and thus can be considered as spatial functional data recorded over time . This allows the investigation not only of normal brains but also of neurological and psychological diseases. However, in many experiments, it is not clear as to whether the data is stationary in time or not.
To assess the stationary in the data, change point detection in sequences of functional data is examined where the spatial functional observations are temporally dependent and where

the distributions of change points from multiple subjects is required. Of particular interest is the case where the change point is an epidemic change (a change occurs and then the observations return to baseline at a later time). The special case where the covariance can be decomposed as a tensor product is considered with particular attention to the power analysis for detection. This is of interest in the application to functional magnetic resonance imaging (fMRI), where the estimation of a full covariance structure for the three-dimensional image is not computationally feasible. It is found that use of basis projections such as principal components for detection of the change points can be optimal in situations where PCA is traditionally thought to perform badly.
The resulting algorithms will be applied to resting state fMRI data. It is shown that in a very large number of subjects the data can have very different properties across the subjects, showing that care needs to be taken in subsequent population based analyses.

A test of significance in functional quadratic regression

Lajos Horváth and Ron Reeder

We consider a quadratic functional regression model in which a scalar response depends on a functional predictor; the common functional linear model is a special case. We wish to test the significance of the nonlinear term in the model. We develop a testing method which is based on projecting the observations onto a suitably chosen finite dimensional space using functional principal component analysis. The asymptotic behavior of our testing procedure is established. A simulation study shows that the testing procedure has good size and power with finite sample sizes. We then apply our test to a data set provided by Tecator, which consists of near-infrared absorbance spectra and fat content of meat.

Thursday:

9.30 - 10.30 Chair: Norbert Henze

Dependent functional linear models with applications to monitoring structural change

Alexander Aue, Siegfried Hörmann, Lajos Horváth and Marie Hušková

In this paper we are concerned with the functional linear model

$$Y_k(t) = \int_0^1 X_k(s)\Psi_k(s,t)ds + \varepsilon_k(t), \qquad t \in [0,1],\, k \in \mathbb{N},$$

so that Y_k, X_k, ε_k are random functions defined on a compact interval, which we assume to be $[0,1]$ and Ψ_k is a possibly time dependent (in k) sequence of operators. Our setting is general enough to include also the important case of functional autoregressive processes.

To see whether or not the functional linear relationship suggested by this model holds with the same operator for all observations, we test the null hypothesis

$$H_0: \quad \Psi \equiv \Psi_1 = \Psi_2 = \dots$$

against the general alternative

$$H_A: \quad \text{There is } k^* \geq 1 \text{ such that } \Psi \equiv \Psi_1 = \dots = \Psi_{m+k^*-1} \text{ but } \Psi^* \equiv \Psi_{m+k^*} = \Psi_{m+k^*+1} = \dots$$

with $\Psi \neq \Psi^*$.

On sequential limit theorems for samples of randomized functions

Ansgar Steland

We study new functional central limit theorems for samples of random functions in continuous time, which can be used to construct sequential detection procedures to detect change-points in functional data. Our results, which are connected to the sequential Kiefer process, cover a wide class of dependence structures. Further, the results for the sequential empirical processes of interest cover the null hypothesis of no- change as well as the asymptotics under a certain general class of alternative models including location-scale models. We discuss a couple of applications in diverse areas such as finance, photovoltaics, engineering and signal analysis, which motivated the research.

11.15 - 12.45 Chair: Bernhard Klar

Monitoring the mean vector and covariance matrix of multivariate time series

Wolfgang Schmid

The aim of statistical process control is to detect deviations from a supposed target process as soon as possible after its occurrence. Because the data are analyzed sequentially a change in the parameters of the target process can be detected much faster than by using conventional fixed-sample tests. The most important tool of statistical process control are control charts. In this talk we present several new control procedures for monitoring the mean and the covariance behavior of a multivariate time series. The target process is assumed to be either a multivariate Gaussian process or a multivariate nonlinear process like, e.g., a constant conditional correlation process. The presented schemes are based on extensions of control charts for independent multivariate random samples given, e.g., by Crosier (1988), Pignatiello and Runger (1990) and Ngai and Zhang (2001). The charts are compared with several other control schemes proposed in literature. The performance of the charts is studied based on the maximum average delay.

Literature:

Bodnar, O. and W. Schmid (2007): Surveillance of the mean behavior of multivariate time series. *Statistica Neerlandica,* 61, 1–24.

Bodnar, O. and W. Schmid (2011): CUSUM charts for monitoring the mean of a multivariate Gaussian process. *Journal of Statistical Planning and Inference,* 141, 2055–2070.

Garthoff, R., Okhrin, I. and W. Schmid (2012): Surveillance of mean vector and covariance matrix of nonlinear time series. Submitted for publication.

W. Schmid and P. Sliwa (2005): Monitoring the cross-covariances of a multivariate time series. *Metrika,* 61, 89–115.

Change-point detection in panel data

L. Horváth and M. Hušková

The talk will concern test procedures that the means of the panels remain the same during the observation period. against an alternative there is a change in the means at an unknown time. More precisely, we consider N panels, each panel with T observations in each panels and the model is specified as follows:

$$X_{i,j} = \mu_i + \delta_i I\{j > k_0\} + e_{i,j}, \;\; 1 \le i \le N, 1 \le j \le T, \tag{1}$$

where $Ee_{i,j} = 0$ for all i and j. According to (1), μ_i changes to $\mu_i + \delta_i$ in case of panel i at time k_0. The parameter k_0, the time of change, is unknown. Both T and N are assumed to be large. We wish to test that the location parameter μ_i will not change during the observation

period, i.e.,

$$H_0 : \quad \delta_i = 0 \quad \text{for all } 1 \leq i \leq N.$$

The presented tests are derived from a likelihood argument and they are based on the adaptation of the CUSUM method to panel data. Asymptotic distributions are derived under the no change null hypothesis and the consistency of the tests are proven under the alternative. The asymptotic results are shown to work in case of small and moderate sample sizes via Monte Carlo simulations.
Change point detection in the above model with N large can be viewed as a structural stability problem in high dimensional time series.

Testing for structural changes in the dependence structure at an unkown point in time

Dominik Wied

There are many empirical hints that the dependence structure of financial assets cannot be assumed to be constant over time. This talk presents a formal statistical test for constant correlation between two time series which can be applied in portfolio optimization problems. The test only needs mild assumptions, e.g. the possible change point need not be known a priori. An adapted functional delta method is used to obtain the asymptotic results. As a second contribution the talk presents corresponding change point tests for copulas or copula-based dependence measures. The procedures are robust against outliers and work well without the assumption of finite moments. We present the extension of a previously suggested test for constant copula in a given point to the case of mixing random variables and present a new test for overall copula constancy. The latter is based on the integral over the empirical copula and simultaneously tests for constancy of Spearman's rho.

14.15 - 15.45 Chair: Roland Fried

Strict stationarity testing and estimation of explosive and stationary GARCH models

Christian Francq

We study the asymptotic properties of the quasi-maximum likelihood estimator of GARCH(1,1) models without strict stationarity constraints, and considers applications to testing problems. The estimator is unrestricted, in the sense that the value of the intercept, which cannot be consistently estimated in the explosive case, is not fixed. A specific behavior of the estimator of the GARCH coefficients is obtained at the boundary of the stationarity region but, except for the intercept, this estimator remains consistent and asymptotically normal in every situation. The asymptotic variance is different in the stationary and non stationary situations, but is consistently estimated, with the same estimator, in both cases. Tests of strict stationarity and non stationarity are proposed. The tests developed for the classical GARCH(1,1) model are able to detect non-stationarity in more general GARCH models. Monte Carlo experiments are used, in particular, to illustrate the behaviour of the test is presence of structural breaks. A numerical illustration based on stock indices and individual stock returns is proposed.

A research program for Fourier-type inference for conditional volatility models

Simos Meintanis

Specification tests are proposed for the innovation distribution of INAR(1) models. The test statistics incorporate the joint probability generating function of the observations and require an initial (non-trivial) estimation step. Special emphasis is given to particular instances of the procedures which involve innovations from the general family of Poisson stopped–sum distributions. A Monte Carlo power study is included as well as real data examples.

15.45 - 17.00 **Poster session**

Monitoring based on partial sums of M-residuals
Ondrej Chochola

The presentation will concern sequential test procedures for detection of changes in multivariate location models and some regression models with dependent observations. The procedures are based on partial sums of M-residuals. Results on the limit behavior of the test procedure will presented. The main focus will be on results of a simulation study.

Asymptotic distribution of the delay time in Page's sequential procedure
Stefan Fremdt

CUSUM procedures have been proposed in the change-point literature in a variety of time series settings and the asymptotic normality of the corresponding stopping time was proven in several of these models. One drawback of the aforementioned procedures that is also reflected in the results on the stopping times is the dependence of their performance on relatively early change-points. We will therefore provide the asymptotic distribution of the stopping time of Page's CUSUM procedure, quantifying that this procedure depends less on the (early) time of change than ordinary CUSUM procedures. The properties of this limiting distribution are then illustrated by the results of a small simulation study.

On the range of validity of the vector autoregressive sieve bootstrap
Marco Meyer and Jens-Peter Kreiss

Extending the results of Kreiss, Paparoditis and Politis (2011), the limits of the vector autoregressive (VAR) sieve bootstrap are explored. This procedure is designed to be applied to multivariate stationary stochastic processes that are linear and invertible since these processes possess an autoregressive representation with independent white noise. However, there is a much wider class of non-linear processes with infinite-order AR representations which have uncorrelated innovations instead of independent ones, only. It will be explored what the VAR sieve bootstrap really does in this more general situation. A so-called companion process, which has a slightly different structure than the original VAR representation of the process, will be defined and it will be shown that the VAR sieve bootstrap asymptotically works if and only if the limiting distribution of the statistic of interest for the original process and the one for the companion process are identical. This yields a general check-criterion for the validity of the VAR sieve bootstrap which will be applied to some important statistics like the sample mean, sample autocovariances and autocorrelations and estimators of the spectral density matrix.

Change-point methods for multiple structural breaks and regime switching models
Birte Muhsal and Claudia Kirch

We introduce a method based on moving sums, which tests for at least one structural break at significance level α and simultaneously estimates the number and locations of change points. We investigate asymptotic properties, such as consistency of the change-point estimators, in case of changes in the mean in an otherwise independently and identically distributed sequence of random variables. Moreover we consider the generalisation of the results to corresponding Regime Switching Models, which in contrast to the classical change-point situation, allow for random change points and an unbounded number of structural breaks.

Quantifying the uncertainty of changepoints in the wavelet domain.
John Aston, Idris Eckley and Christopher Nam

We will present recent work in quantifying the uncertainty of changepoints (CPs) for a time

series via wavelet transforms. This builds upon the flexible approach of Nam et al (2011) which uses Hidden Markov Models (HMMs), Finite Markov Chain Imbedding (FMCI) and Sequential Monte Carlo (SMC) samplers in providing a generalised posterior distribution for CP characteristics in light of parameter uncertainty. Here, we consider working with the finest scale wavelet coefficients from a non-decimated, stationary wavelet transform as an alternative to directly working with the observed time series. The finite, localised behaviour of wavelets permits the use of generalised HMMs to model the wavelet process, with dependency on previous wavelet coefficients accounted for in a well defined manner, dependent on the mother wavelet choice. This allows the modelling of a wide range of processes via the transform while still making use of the advantages of a Rao-Blackwellised SMC estimate of the CP distribution.

Linear processes on lattices - asymptotics for auto-covariances and integrated periodograms
Tobias Niebuhr

We generalize the well-known asymptotic properties for linear processes that base on observations without any gaps. Allowing for gaps of fixed size, relevant asymptotic results turn out to depend on the gap size. A generalized central limit result for the auto-covariance estimator is presented and further we show a generalization of the central limit result for integrated periodograms. Depending on the size of the gaps, we point out which statistics yield the standard results and for which statistics the asymptotic behavior differs. Furthermore, we present an estimation proposal for specific autoregressive processes for this situation and discuss bootstrap possibilities.

AIC for estimating the number of structural breaks
Yoshiyuki Ninomiya

The purpose of the presentation is to derive AIC for change-point models. The penalty term of the AIC is an asymptotic bias of twice the maximum log-likelihood multiplied, and it becomes twice the number of parameters in regular models. In change-point models, however, the asymptotic bias does not become twice the number because of their irregularity. In this presentation, it is shown that the asymptotic bias becomes six times the number of change-points plus twice the number of the other regular parameters. Moreover, it is shown by simulation study that the derived AIC provides reasonable model selection in comparison with the naive AIC. Finally, it is demonstrated that two AIC's select different change-point models for some commonly-used real data, which means that the difference between two AIC's is not ignorable.

Testing for a change of the innovation distribution in nonparametric autoregression - the sequential empirical process approach
Leonie Selk and Natalie Neumeyer

Weak convergence results for sequential empirical processes based on nonparametrically estimated residuals in heteroscedastic autoregressive models are presented and a testing procedure that can detect a change in time in the innovation distribution is proposed. Our main theorem gives a stochastic expansion for sequential empirical processes based on nonparametrically estimated residuals. This stochastic expansion consists of a sum of independent random variables and an error term of a small rate. Therefore known results for independent random variables can be used to proof weak convergence to a Gaussian process. From this, next to change point tests, also goodness of fit tests can be deduced, because the result for sequential empirical processes implies the same for nonsequential ones. The described approach is similar to derivations of nonparametric change point tests that exist for the regressive case. In the autoregressive case two additional problems arise. The observations are dependent and the support of the process cannot be assumed to be compact, contrary

to the support of the covariates in regression. These problems are solved by replacing the assumption of independence by a mixing condition and using stochastic weights that restrain the support of the observations to compact intervals converging to the real line. The test statistic for the change point test is based on the difference of appropriately adjusted sequential empirical processes of nonparametrically estimated residuals. Weak convergence of this difference can be deduced from the stochastic expansion and it is shown that the same asymptotic representation as in the regressive case can be achieved. In particular the considered test statistic is asymptotically distribution free and known asymptotic quantiles can be used for the test. Simulations of several types of change points and different models support the theoretical results.

Detecting a gradual change in an open-end setting

Hella Timmermann

A lot of research in change point analysis focuses on the detection of an abrupt change, whereas in the case of gradual changes fewer results are known. We develop a monitoring procedure for detecting such a gradual change in the drift parameter of a general stochastic process (satisfying some weak invariance principle) in an open-end setting. We will look at the asymptotic distribution of the detector under the null hypothesis, the consistency of the test and the asymptotic distribution of the stopping time under the alternative. It turns out, that different weight functions are needed, depending on whether we have known (in control) or unknown parameters. The finite sample behavior is investigated in a small simulation study.

A Darling-Erdős-type CUSUM-procedure for functional data

Leonid Torgovitski

A widely used approach to test for a change in the mean of functional data are CUSUM-procedures which rely on functional limit theorems. These procedures are based on projections of the infinite dimensional functional observations on the finite dimensional subspace(s) spanned by $p \geq 1$ leading (empirical) functional principal components.

Robust Change Point Detection under Dependence

Martin Wendler

We present a robust test for structural break under dependence based on the maximum of the two-sample Hodges-Lehmann estimator. To investigate its asymptotics, we prove a functional central limit theorem for two-sample-U-quantiles. Our results apply to observations which are near epoch dependent on an underlying mixing process.

17.00 - 18.30 Chair: Herold Dehling

Testing, monitoring and dating structural changes in exchange rate regimes

Achim Zeileis

Linear regression models for currency returns are typically used for classifying "de facto" exchange rate regimes, i.e., for determining whether a certain currency is pegged to one or more other currencies. Therefore, practitioners routinely use rolling regressions to track the evolution of the exchange rate regime in operation for a particular country. This exploratory approach is complemented by inferential techniques for evaluating the stability of the regimes. To simultaneously assess parameter instabilities in the regression coefficients and the error variance an (approximately) normal regression model is adopted and a unified toolbox for testing, monitoring, and dating structural changes is provided for general (quasi-)likelihood-based regression models. Subsequently, the toolbox is employed for investigating the Chinese exchange rate regime after China gave up on a fixed exchange rate to the US dollar in 2005 and for tracking the evolution of the Indian exchange rate regime from 1993 until 2008.

Reference:
Achim Zeileis, Ajay Shah, Ila Patnaik (2010). "Testing, Monitoring, and Dating Structural Changes in Exchange Rate Regimes", *Computational Statistics & Data Analysis*, 54, 1696-1706. doi:10.1016/j.csda.2009.12.005

Sequential robust testing of stability in CAPM model

Zuzana Prašková

We consider capital assets pricing model (CAPM) in the form of a multivariate regression model with time varying parameters. For testing stability of portfolio betas we propose a sequential robust multivariate procedure that, unlike most of the existing tests which are based on the least-squares estimators, uses M-estimators and partial weighted sums of M-residuals. An asymptotic representation of M-estimators and testing statistic when both regressors and errors are weakly dependent is established and asymptotic properties of the test statistic both under the null and alternative hypotheses are studied.

Local Gaussian correlation detecting financial cointegration

Dag Tjøstheim

We study a new measure of local dependence, namely local Gaussian correlation, and its application to financial contagion, that is whether the cross market linkages in financial markets increase after a shock to a country. The central idea of the new approach is to approximate an arbitrary bivariate return distribution by a family of Gaussian distributions. At each point of the return distribution there is a Gaussian distribution that gives a good approximation at that point . The correlation of the approximating Gaussian is taken as the local correlation. By examining the local Gaussian before the shock (stable period) and after the shock (crises period) we are able to test whether contagion has occurred by a bootstrap testing procedure. We illustrate the approach by several crises (Mexican, Asian, finance crises).

Friday:

9.30 - 10.30 Chair: Henze

Shrinkage estimation for multivariate Hidden Markov Mixture Models

Joseph Tadjuidje-Kamgaing

Hidden Markov Models (HMM) are a popular class of models for time series which locally (within a state) behave like i.i.d. data, but repeatedly change the data-generating regime. To name just one example, a simple but wide-spread model for the vector of returns of all assets in a stock portfolio is based on the assumption that the data are independent Gaussian random vectors with covariance matrix Σ resp. volatility matrix $\Sigma^{1/2}$. However, if the market environment changes, e.g. if it moves to a more volatile state, the covariance matrix changes, too. This behaviour can be modelled by a HMM with a finite number, say K, of states represented by the different covariance matrices $\Sigma_k, k = 1, \ldots, K$. A prime goal would be to estimate the model parameters represented by all the $\Sigma_k, k = 1, \ldots, K$, as well as the transition matrix of the hidden Markov chain and, additionally, a filter which allows for the reconstruction of the values of the hidden Markov chain. For applying the fitted model to financial tasks like the calculation of risk measures, stable estimates of the inverse covariance matrices are also needed which, in view of the typical high dimension of the data, is no trivial task.
We consider high-dimensional data generated by hidden Markov models. To get more stable estimates of the covariance matrices, we apply shrinkage and combine it with an EM-type algorithm. The final algorithm also reproduces better estimates for the transition matrix and

a more stable and reliable filter. We also present some theoretical results which provide the motivation for certain techniques used in the algorithm.

10.30 - 11.45 **Poster session**

Darling–Erdős type statistics for panel data

Julian Chan, Lajos Horváth and Marie Hušková

We assume that we have N panels and each panel is based on T observations. It is assumed that the panels are independent but the panels maybe based on dependent observations. We would like to test the null hypothesis that the means remain the same in the panels during the observation period against the alternative that the means may have changed in some of the panels. Using quasi likelihood ratio arguments the best test is based on self–normalized CUSUM statistics. We provide the limit distribution of the proposed statistic under the null hypothesis and provide a small simulation study in the case of small and moderate sample sizes.

Efficient score test for vector autoregressive models

Marek Dvořák

We present a test for change-detection in parameters of a vector autoregressive process based on the efficient score vector. This form of test has several advantages over the procedure based on the likelihood ratio: It allows us to test one-sided alternatives and also achieves higher power in case of the normally distributed errors. We compare both methods in the performance under the null and alternative hypothesis.

"A first course on time series analysis with SAS", an open-source book project

Michael Falk, Frank Marohn, René Michel, Daniel Hofmann, Maria Macke, Bernward Tewes, Peter Dinges, Christoph Sprachmann and Stefan Englert

"A First Course on Time Series Analysis with SAS" is an open source book project to create a mathematically oriented introduction to time series analysis. The book links up elements from time series analysis with a selection of statistical procedures used in general practice including the statistical software package SAS. The central platform of the project is an internet page (http://www.statistik-mathematik.uni-wuerzburg.de/timeseries/) that provides the compiled version and the source code of the text as well as all SAS-programs and datasets used in the book. As part of this open-source-project under the GNU Free Documentation License, everybody can use, modify and contribute to the text, programs and datasets. We hope that, as time goes by, evolution takes place and leads to a steadily improving text. In 2011, a new revised version of the book was made available and it is intended that in regular intervals new versions will be published on the web page. Thus resulting in a "dynamic book" that can be adjusted to reflect the changing needs. This book primary addresses students of statistics as well as students of other subjects with lectures on statistics such as economics, demography and engineering. However, it is also intended for the practitioner who, beyond the use of statistical tools, is interested in the mathematical background. Numerous problems illustrate the applicability of the presented statistical procedures, where SAS gives the solutions. All programs used are explicitly listed and explained. Its content includes exploratory time series analysis, models of time series (incl. a case study on the Box-Jenkins methodology), state-space models, the spectrum of a stationary process and statistical analysis of time series in the frequency domain.

References: Falk, M; Marohn, F; Michel, R; Hofmann, D; Macke, M; Tewes, B; Dinges, P; Spachmann, C; Englert, S; A First Course on Time Series Analysis : Examples with SAS. http://statistik.mathematik.uni-wuerzburg.de/timeseries/ (2011)

Bootstrapping realized volatility and realized bipower variation

Gang Feng and Jens-Peter Kreiss

Realized volatility and realized bipower variation are often used to measure the volatility in financial markets on the basis of high frequency intraday data. Considering a nonparametric volatility model, we propose a nonparametric bootstrap procedure by resampling estimated noise innovations based on discrete time returns, in order to approximate the distribution of realized volatility and realized bipower variation. Asymptotic validity of the proposed procedure is proved. Furthermore, the finite sample properties of the proposal are investigated in a simulation study and are also compared to other bootstrap methods.

Bootstrap for random coefficient autoregressive models

Thorsten Fink and Jens-Peter Kreiss

For a bootstrap procedure, we usually need to have i.i.d. random variables that we obtain easily given an estimator for the autoregressive coefficient in the standard autoregressive model. If the coefficient is modeled stochastically, the standard proce- dure does not work anymore, because one would obtain the convolution of two random variables, namely the innovations and the stochastic coefficient. We present an ap- proach to obtain estimated residuals for both of the variables separately. Together with a least-squares estimator for the fourth moments of both the innovations and the stochastic autoregressive coefficient, these ideas lead to a modification of the standard residual based bootstrap procedure for the mean of the autoregressive coefficient. Its consistency is established. Further, we introduce a wild bootstrap based on a quasi-maximum likelihood esti- mator that works under very mild conditions on the process. We establish its consistency for the distribution of the estimator for the coefficient's mean and for the distribution of the estimators for the variances of both the innovations and the coefficient. Finally, the benefit of the bootstrap procedures is illustrated by a simulation study.

On Bayesian non-parametric modelling of time-series data

Juan C. Martínez-Ovando and Stephen G. Walker

We present a general construction of non-parametric first-order stationary time-series models for which marginal (invariant) and transition distributions are expressed as infinite-dimensional mixtures. We draw on the discussion of using stationary models in practice, as a motivation, and advocate the view that flexible (non-parametric) stationary models might be a source for reliable inferences and predictions. It will be noticed that our models adequately fit in the Bayesian inference framework due to a suitable representation theorem. A stationary scale-mixture model (with and without exogenous covariates interventions) is developed as a particular case along with a computational strategy for posterior inference and predictions. We present some illustration in the analysis of real- and discrete-valued econometric time-series data.

Change-point analysis based on estimating functions

Stefan Mihalache

Our motivation is to test for changes in the multi-dimensional parameter of multivariate diffusion processes observed as discrete time series. We want the parameters to be involved in the drift as well as the diffusion coefficient. Since for discretely sampled diffusions the likelihood is usually unknown, the theory of estimating functions, which generalise the score function, seems to be promising in order to tackle the problem. Toward this end, a general parametric statistical model and an estimator given as a root of an estimating function $G_n(\theta)$ are considered. Based on the theoretical fundament of J. Jacod and M. Sørensen (2010), we give sufficient regularity conditions on G_n (including rates of growth) such that the estimator process $n(\hat{\theta}_n - \theta_0)$ can be a.s. approximated by a Wiener process with a rate of the order

$\mathcal{O}(n^{1/2-\varepsilon})$ for some $\varepsilon > 0$. Armed with this tool, it is possible to construct a posteriori as well as sequential procedures for testing of changes in the parametric law of observed time series as soon as a suitable estimating function is available. Then, (dependency) structures of estimating functions and of the observed processes are discussed which satisfy the required theoretical conditions. Applications to concrete SDEs illustrate the test procedures.

J. Jacod and M. Sørensen (2010). Aspects of asymptotic statistical theory for stochastic processes. Preprint, Department of Mathematical Sciences, University of Copenhagen. In preparation.

Detecting change-points in AR time series with dependent errors

Katarina Starinska

In this contribution we present the basic steps of construction of the efficient score test statistic for detecting change-points in an autoregressive (AR) time series. We study the AR time series under the assumption that the error process is a martingale difference sequence. Furthermore, we state conditions, under which the statistic for this time series converges to the vector of independent Brownian bridges. As an application, the statistic can be used for detecting changes in parameters of a generalized integer autoregressive process.

Estimating the volatility of electricity prices: The case of the England and Wales wholesale electricity market

Sherzod Tashpulatov

Price fluctuations that partially comove with demand are a specific feature inherent to liberalized electricity markets. The regulatory authority in Great Britain, however, believed that sometimes electricity prices were significantly higher than what was expected and, therefore, introduced price-cap regulation and divestment series. In this study, I analyze how the introduced institutional changes and regulatory reforms affected the dynamics of daily electricity prices in the England and Wales wholesale electricity market during 1990-2001. This research finds that the introduction of price-cap regulation did achieve the goal of lowering the price level at the cost of higher price volatility. Later, the first series of divestments is found to be successful at lowering price volatility, which however happens at the cost of a higher price level. Finally, this study also documents that the second series of divestments was more successful at lowering both the price level and volatility.

An efficient and robust test for a change-point in correlation

Herold Dehling, Daniel Vogel, Martin Wendler and Dominik Wied

We present an asymptotic change-point test for correlation based on Kendall's tau. Suppose we observe a bivariate time series $((X_i, Y_i))_{i=1,\dots,n}$. The null hypothesis of the proposed test is that Kendall's rank correlation between X_i and Y_i stays constant for all $i = 1, \dots, n$. We assume $((X_i, Y_i))_{i=1,\dots,n}$ to be stationary and near epoch dependent on an absolutely regular process. This large class of processes includes all common time series models as well as many chaotic dynamical systems. In the derivation of the asymptotic distribution of the test statistic the U-statistic representation of Kendall's tau is employed. Kendall's tau correlation coefficient possesses a high efficiency at the normal distribution, as compared to the normal MLE, Pearson's correlation measure. But contrary to Pearson's correlation coefficient it has excellent robustness properties and shows no loss in efficiency at heavy-tailed distributions. This combination of efficiency and robustness is the advantage of our test over previous proposals of tests for constant correlation. Furthermore, the asymptotic variance of Kendall's tau has a tractable analytic form (in contrast to Spearman's rho for instance), which facilitates the practical implementation of the test.

Statistical inference for partially observed systems

Vladimir Zaiats and Yu Kutoyants

I do not know him but when I asked him about the topic he told me that he is highly interested in the workshop topic as 'The framework I am currently working in is susceptible for application of structural breaks when the underlying function changes. Though my framework is rather in continuous time, I am highly interested in the workshop's topic: I would like to see whether the time series techniques for structural breaks could be useful in our problems.' We consider several problems of non-parametric estimation in a two-component system described by stochastic differential equations where the component we would like to control is not observed. Another component which is observed is also a stochastic process related to the first component. We assume that each component is perturbed by a small noise. In this setting, four different functions can be estimated from the component available for observation on a closed time interval. For each of these functions, we build a kernel-type estimator, prove its consistency as the noise becomes smaller, and obtain asymptotically optimal rates of convergence. The author has been supported by the Universitat de Vic under grant R004.

11.45 - 12.45 Chair: Roland Fried

Change point analysis for time series of counts

Jürgen Franke

Recently, integer-valued stochastic processes have found renewed interest as models for time series of counts, e.g. in financial or medical applications. We consider general nonlinear versions of basic models of that kind, e.g. of Poisson autoregressions of order given by

$$\mathcal{L}\{X_{t+1}|X_t\} = \text{ Poisson } (\lambda_t), \quad \lambda_t = g(X_t, \theta), \tag{0.1}$$

where $g(x, \theta)$ is a known function parametrized by $\theta \in \Theta$.
Under appropriate conditions on g, which for the special case of linear Poisson autoregressions reduce to the usual stationarity conditions, there is a strictly stationary process which is strongly mixing with exponentially decreasing dependence coefficients. This short memory condition allows to develop procedures for testing for and estimating changepoints in time series of counts. We consider such a test for nonlinear Poisson autoregressions and present an application to epileptic seizure counts.

J. Dedecker, P. Doukhan, G. Lang , J.R. León, S. Louhichi and C. Prieur. *Weak Dependence: With Examples and Applications*. Lecture Notes in Statistics **190**. Springer, Berlin-Heidelberg-New York, 2007.

Robust estimation for time series following GLM

Konstantinos Fokianos, Roland Fried and Stella Kitromilidou

We are investigating the problem of robust estimation in the context of time series following GLM. Two main examples are considered; the case of logistic models for binary time series and the case of log–linear models for count time series. Both of these examples are considered under the situation where a possible outlying (or extraordinary) observation is present. The case of a permanent level shift can be considered in this framework as a limiting case. Such observation can be thought as a result of an innovation data generating process that influences externally the behavior of the observed time series. We discuss the effects of these observations to inference; in particular focus is on estimation of regression coefficient. We propose some methods for robust estimation. Our results are empirical at the moment but indicate that methods that have been proposed for independent data can be suitably adopted to the case of binary and count time series.

14.00 - 15.30 Chair: Claudia Kirch

Segmenting mean-nonstationary time series via trending regressions

Alexander Aue, Lajos Horváth and Marie Hušková

In this talk, we discuss a segmentation procedure for mean-nonstationary time series. The segmentation is obtained by casting the problem into the framework of detecting structural breaks in trending and possibly dynamic regression models in which the regressors are generated by suitably smooth (random) functions. As test statistics we propose to use the maximally selected likelihood ratio statistics and a related statistics based on partial sums of weighted residuals. The main theoretical contribution of the paper establishes the extreme value distribution of these statistics and their consistency. To circumvent the slow convergence to the extreme value limit, we propose to employ a version of the circular bootstrap. This procedure is completely data-driven and does not require knowledge of the time series structure. In an empirical part, we demonstrate through a simulation study, and applications to air carrier traffic and S&P 500 data that the finite sample performance is very satisfactory.

Bootstrapping stationary and locally stationary processes

Jens-Peter Kreiss and Stathis Paparoditis

We propose a nonparametric method to bootstrap stationary and locally stationary processes, which combines a time domain wild bootstrap approach with a nonparametric frequency domain approach. The method generates pseudo-time series which (asymptotically) correctly mimic the (local) second and to the necessary extent the fourth order moment structure of the underlying process. Thus it can be applied to approximate the distribution of statistics of interest that are based on observations of the (locally) stationary process. We prove a bootstrap central limit theorem for a general class of statistics that can be expressed as functionals of the periodogram and accordingly the preperiodogam.

On bootstrap based detection of discontinuities in trend functions under long memory

Jan Beran and Yevgen Shumeyko

Wavelets provide a natural approach to detecting discontinuities in trend functions. Here, we focus on the case of strongly dependent residual processes. In the first part of the talk, data adaptive optimal wavelet thresholding will be discussed. Asymptotic formulas for the MISE are derived including multiplicative constants. The results obtained here lead to the solution of the question asked in the second part of the talk, namely data adaptive detection of discontinuities. A decomposition into a low resolution component without thresholding and a high resolution component is used to derive a boostrap test against the alternative of at least one discontinuity.