MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

Tagungsbericht 9/1998

Mathematische Stochastik

01.03. bis 07.03.98

Die Tagung fand unter der Leitung von R. Dahlhaus (Heidelberg), A. Frigessi (Oslo) und H.R. Künsch (Zürich) statt. Neben bekannten Spezialisten aus der Wahrscheinlichkeitstheorie und der Statistik nahmen auch mehrere jüngere Forscher teil. Ein wesentlicher thematischer Schwerpunkt der Tagung war die Modellierung und Analyse zeitlicher und räumlicher Prozesse. Viele wichtige Probleme aus diesem Bereich führen unmittelbar sowohl zu wahrscheinlichkeitstheoretischen als auch zu statistischen Fragestellungen (z.B. die Verwendung von Gibbsfeldern für die Bildanalyse). Deshalb war der intensive Gedankenaustausch zwischen Wahrscheinlichkeitstheoretikern und Statistikern in diesem Bereich sehr nützlich. Konkret bezogen sich die Vorträge auf die Gebiete Finanzzeitreihen, Simulationstechniken mit Markov-Ketten (MCMC) sowie die zugehörigen Konvergenzsätze, Zufallsfelder, Wavelet-Methoden, Zeitreihen mit langanhaltender Abhängigkeit, stabile stochastische Prozesse sowie nichtparametrische Methoden für Zeitreihen.

L. BREYER

From Metropolis to diffusions: Gibbs states and optimal scaling

In this talk we consider the Random Walk Metropolis algorithm X^n for an n-dimensional target distribution π_n. This algorithm has one parameter σ_n^2, the variance of the proposal step. By speeding up time and correspondingly reducing σ_n, we give as n tends to infinity an infinite dimensional diffusion approximation Z. This diffusion Z has the appealing property that one can optimize its speed of evolution in time, which yields the corresponding possibility of optimizing the efficiency of the Metropolis algorithm X^n, when n is large.

P. BÜHLMANN

Variable length Markov chains

Partially joint work with A.I. Wyner.

We introduce the class of stationary, possibly parsimonious, Markov chains having a memory of variable length.

Estimation of the minimal state space and the underlying probability distribution is done with a modified version of the tree structured context algorithm, introduced by Rissanen (1983) for data compression. We show consistency in an asymptotically infinite-dimensional setting, asymptotic efficiency for smooth functionals of the underlying distribution and data-driven tuning of the context algorithm.

F. COMETS

Information and Markov fields

Joint work with O. Zeitouni

If $H_n(\mu|\nu)$ denotes the information of μ with respect to ν on the cube $[-n,n]^d = \Lambda_n$ in $\mathbb{Z}^d$, and if ν is Markov, weak-mixing (in the sense of Dobrushin-Shlosman) we prove that

$$\frac{2}{|\{j : j + \Lambda_m \subset \Lambda_n\}|} \sum_{j:j+\Lambda_m\subset\Lambda_n} \| \mu-\nu \|^2_{j+\Lambda_m} \leq \alpha(m,n)H_n(\mu|\nu)+\varepsilon_1(n)+\varepsilon_2(m)$$

where $\| \cdot \|_V$ denotes the variational distance on V; $\alpha(m,n) \sim (\frac{m}{n})^d$ as $m,n \to \infty$ and $\varepsilon_1(n), \varepsilon_2(m) \to 0$ are explicit. We have applications to mean-field perturbations of Gibbs measures and to mean-field spin-glass perturbations of deterministic Gibbs measures.

L. DAVIES

Data approximation using stochastic models

It is argued that a stochastic model P is an adequate approximation for a data set $\underline{x}_n = (x_1, \ldots, x_n)$ if data generated by P $(X_1(P), \ldots, X_n(P))$ look like the actual data $\underline{x}_n$. Using this simple idea it is possible to develop methods to produce non-parametric regression functions. The main idea is to keep the number of extreme values under control and then to smooth the function. Examples are given using real and constructed data sets.

H. DEHLING

From dimension estimation to the asymptotics of dependent U-statistics

For a probability distribution μ on $\mathbb{R}^k$ we define the correlation integrals $C(r) = \mu \times \mu(\{(x,y) : \| x - y \| \leq r\}) = P(\| X - Y \| \leq r)$, where X and Y are independent random variables with distribution μ. If $C(r) \approx cr^d$ as $r \to 0$, we call d the correlation dimension of μ. In our talk we discuss the problem of estimation of $C(r)$ and μ based on a finite sample $X_1, \ldots X_n$ from a stationary ergodic process $(X_k)_{k \geq 1}$. The natural estimator for $C(r)$ is the sample correlation integral $C_n(r) = \frac{1}{\binom{n}{2}} \sum_{1 \leq i < j \leq n} 1_{\{\|X_i - X_j\| \leq r\}}$ which has the form of a bivariate U-statistics $U_n(h) = \frac{1}{\binom{n}{2}} \sum_{1 \leq i < j \leq n} h(X_i, X_j)$. We then study asymptotic properties of such U-statistics. Concerning the Law of Large Numbers, we provide a counter example showing that

$$U_n(h) \to \int\int h(x,y) \; d\mu(x) \; d\mu(y)$$

might fail. On the other hand, convergence holds if either (i) h is bounded and $\mu \otimes \mu$ - a.e. continuous. or (ii) h is bounded and (X_k) is absolutely regular. (Aaronsou, Burton, Dehling, Gilat, Hill, Weiss, TAMS 1996). We further present recent work of Borovkova, Burton, Dehling establishing weak convergence of the U-process

$$(\sqrt{n}(C_n(r) - C(r)), \; 0 \leq r \leq r_0)$$

to a mean zero Gaussian process $(W_r, 0 \leq r \leq r_0)$. This result can be proved for functionals of absolutely regular sequences.

M. DI ZIO

Smoothness in Bayesian nonparametric regression with wavelets

We discuss a Bayesian formalism, in wavelet context, for the non-parametric regression problem.

In particular we focus our attention on the regularity of the unknown function. Abramnavich, Sapatine, Silverman (1996) show that it is feasible to incorporate prior knowledge about the function's regularity properties into the prior model for its coefficients. It seems important, at least for a coherence principle, to have an estimator which has the same regularity assumed for the unknown function. To achieve this goal, we propose to use as loss function the Besov norm. In fact in this case, if we suppose that f has a certain degree of regularity, then the estimates we obtain will have the same degree of smoothness. Because of the difficulty of finding conditional solutions for the estimates, we propose a stochastic algorithm composed of two steps. In the first step we compute an approximation of the Bayesian risk and in the second step we minimize the previous quantity; this algorithm will lead us to compute an approximation of the optimal Bayesian estimator corresponding to the loss function given by the Besov norm.

E. EBERLEIN

More realistic modeling in finance

Joint work with U. Keller and S. Raible.

Extensive empirical investigaions showed that the implicit assumption of normal log returns made in the classical diffusion model for stock prices cannot be justified. As more realistic we introduce a new model given by the equation

$$dS_t = S_{t^-}(\mu dt + \sigma dX_t + e^{\sigma \Delta X_t} - 1 - \sigma \Delta X_t)$$

where (X_t) is a hyperbolic Lévy motion. The solution of this equation is positive and has hyperbolic log returns. The process has purely discontinuous paths and thus at the same time provides a more realistic picture if one looks at intraday stock price behaviour. We discuss a number of results on option pricing and value at risk based on this model.

These results for stock prices motivate a similar generalization of Gaussian term structure models. After some analysis of stochastic differential equations we get the model in the following explicit form

$$P(t,T) = P(0,T) \cdot \exp[\int_0^t (r(s) - \theta(\sigma(s,T)))ds + \int_0^t \sigma(s,T)dX_s]$$

where $r(s)$ denotes the short rate and $\theta(u) = \log(E[\exp(uX_1)])$. (X_t) is now a general Lévy process satisfying an integrability condition which guarantees that $\theta(u)$ is finite.

Numerically we investigate the case where the driving process is a hyperbolic Lévy motion and the volatility σ has a Vasiček structure. Hyperbolic forward rates turn out to be higher than Gaussian rates. We also compute option prices using the underlying martingale measure.

P. EICHELSBACHER

Compound Poisson approximation via Stein's method

Joint work with M. Roos.

We consider compound Poisson approximation by Stein's method for dissociated random variables. We present some applications to problems in system reliability such as k-runs, colouring graphs and two dimensional consecutive-k-out-of-n-systems.

In particular our examples have the structure of an incomplete U-statistics. For nonnegative integer valued complete U-statistics improvements of the Poisson approximation results cannot be expected. We mainly apply techniques from Barbour and Utev, who gave new bounds for the solutions of the "Stein equation" in compound Poisson approximation in two recent papers.

I. GAUDRON

Fluctuations of empirical means at low temperature for finite Markov chains with rare transitions

The integrated autocovariance and autocorrelation time are essential tools to understand the dynamical behaviour of a Markov chain. We study these two objects for Markov chains with rare transitions with no reversibility assumption. We give upper bounds for the autocovariance and autocorrelation time, as well as exponential equivalents at low temperature. We also link their slowest modes with the underlying energy landscape. Our proofs are based on large deviation estimates coming from the theory of Wentzell and Freidlin (1984), Catoni (1992) and Trouvé (1996), and on coupling arguments.

L. GIRAITS

Whittle estimator for finite-variance non-Gaussian time series with long memory

We consider time series $Y_t = G(X_t)$ where X_t is Gaussian with long memory and G is a polynomial. The series Y_t may or may not have long memory. The spectral density $g_\theta(x)$ of Y_t is parametrized by a vector θ and we want to estimate its true value θ_0. We use a least-squares Whittle-type estimator $\hat{\theta}_N$ for θ, based on observations $Y_1, \ldots, Y_N$. If Y_t is Gaussian, then $\sqrt{N}(\hat{\theta}_N - \theta_0)$ converges to a Gaussian distribution. We show that for non-Gaussian time series Y_t, this $\sqrt{N}$ consistency of the Whittle estimator does not always hold and that the limit is not necessarily Gaussian. This can happen even if Y_t has short memory.

F. GÖTZE

Values of quadratic forms and lattice point problems

Joint work with V. Bentkus

We investigate the lattice point remainder, i.e. the number of lattice points minus the Lebesque measure, of general ellipsoids and intersections of large cubes with hyperboloids in $\mathbb{R}^k$. For $k \geq 9$ this remainder is shown to be of order $o(R^{k-2})$ for irrational ellipsoids with an 'explicit' error bound. For rational ellipsoids it is of order $O(R^{k-2})$. This result is used to prove the conjecture of Davenport and Lewis (1972) that the gap between successive values of positive definite forms tends to zero for growing values, provided $k \geq 9$. Furthermore, effective bounds are proved as well for the hyperboloid case. This yields a quantitative refinement for the error in the quantitative Oppenheim conjecture, recently proved by Eskin, Marjulis and Mozes (1997) for $k \geq 9$.

P.J. GREEN

Exact MCMC sampling in a continuous state space

Joint work with D. Murdoch.

A couple of years ago Propp and Wilson (Random Structure and Algorithms, 1996) introduced a beautiful idea that on the face of it solved the problem of diagnosing convergence in Markov chain Monte Carlo simulation. Their "Coupling from the Past" protocol (CFTP) provides a rigorous way of organising a MCMC simulation that by starting multiple paths a random time in the past delivers an <u>exact</u> sample from the target distribution at time 0.

In this talk, we describe methods for doing CFTP on continuous state spaces, with the objective of eventually developing methods for routine use in Bayesian parametric inference. (Most previous applications have worked with discrete spatial systems and point processes which although involving many variables are rather homogeneous, and in any case possess aspects of discreteness and monotonicity that facilitate CFTP). Three basic methods are introduced - multigamma coupling, rejection coupling and coupled random walk Metropolis. The methods are illustrated on toy examples and on one real but small Bayesian problem.

C. GREENWOOD

When is an empirical estimator for a Gibbs field optimal?

Joint work with Wolfgang Wefelmeyer.

The expectation of a local function on a stationary random field can be estimated from observations on a large window by the empirical estimator, i.e. the average of the function over all shifts within the window. We show that for Gibbs fields with local interactions the empirical estimator is efficient when the function is a sum of functions each of which depends only on the values of the field on a clique. If the function is not of this form we construct a better estimator using Markov splitting of the law of the field.

R. GRÜBEL

More on Hoare's selection algorithm

Hoare's selection algorithm finds the k^{th} order statistic of a set $S \subset \mathbb{R}$, $\#S < \infty$. The basic recursion step selects a partitioning element uniformly at random from S. We discuss tail bounds and convergence in distribution of the number of comparisons required and briefly consider alternative partitioning stategies. The recursiveness of the basic algorithm reflects itself in some selfsimilarity properties of the associated limiting Markov processes.

J. HIDALGO

Estimation of the pole of a long-range process

Given a covariance stationary process, X_t, with spectral density $f(\lambda)$, it is assumed that at some unknown frequency $\lambda^o \in [0, T_1]$, $f(\lambda) \sim C|\lambda - \lambda^o|^{-2d}$ where $C > 0$ and $d \in (0, \frac{1}{2})$. In this paper, we propose and study an estimator of λ^o and d. As for the estimation of λ^o, we show that not only the estimator is consistent, but that it converges in distribution, after some appropriate normalization, to a normal distribution when $\lambda^o \in (0, \pi)$ and to a distribution which takes the value 0 with probability $\frac{1}{2}$ and (half)normal for positive (negative) values when $\lambda^o = 0\ (\pi)$. With respect to the estimator of d, by a simple use of the functional mapping theorem, we show that its distribution is the same irrespective of whether or not λ^o is known, so that we extend results already obtained in the literature with respect to the estimation of d where λ^o is known a priori.

C. KLÜPPELBERG

Extremal behaviour of *ARCH*-type processes

As a prototype of a class of models, which have proved useful in mathematical finance, we consider the $AR(1)$ process with $ARCH\,(1)$ errors

$$X_n = \alpha X_{n-1} + \sqrt{\beta + \lambda X_{n-1}^2}\varepsilon_n,\ n \in \mathbb{N},\ X_o \text{ independent of } (\varepsilon_n)_{n\in\mathbb{N}},$$

where (ε_n) are iid standard normal and the parameters $\alpha \in \mathbb{R}$, $\beta, \lambda > 0$ satisfy certain conditions. These conditions involve the function $h_{\alpha,\lambda}(u) =$

$E|\alpha + \sqrt{\lambda}\varepsilon|^u$, $u \geq 0$, which has to satisfy $h'_{\alpha,\lambda}(0) < 0$. For such values α and λ $\exists \kappa > 0 : h_{\alpha,\lambda}(\kappa) = 1$ and in this case (X_n) is geometric ergodic. Let X be a random variable with stationary distribution of (X_n). We show that

$$P(X > x) \sim cx^{-\kappa}, \quad x \to \infty,$$

for some $c > 0$, which can be given explicitly. We also show that the point process of exceedances of the stationary process (X_n) converges to a marked Poisson process, where the marks describe the clustersize of exceedances over a high threshold. The extremal index and the cluster probabilities can be obtained by means of the random walk $S_n = \sum_{k=1}^{n}(\alpha + \sqrt{\lambda}\varepsilon_k)$, $n \in \mathbb{N}$.

H. KOUL

On the estimation of the long memory parameter

This talk discusses the effect of the rate of consistency of the regression parameter in a non linear regression model on the estimation of the dependence parameter of the long memory errors. In particular, if the errors are Gaussian long memory and the regression parameter has a $\sqrt{n}$-consistent estimator, then $\sqrt{n}$ (dependence parameter estimator - the dependence parameter) has asymptotic normal distribution for all parameter values.

J.-P. KREISS

Bootstrap tests for simple structures in nonparametric time series regression

Joint work with M. Neumann and Q. Yao.

The talk concerns statistical tests for simple structures such as parametric models, lower order models and additivity in a general nonparametric autoregression setting. We propose to use a modified L_2-distance between the nonparametric estimator of a regression function and its counterpart under null hypothesis as our test statistic. The asymptotic properties of the test statistic are established, which indicates the test statistic is asymptotically equivalent to a quadratic form of innovations. A regression type resampling scheme (i.e. wild bootstrap) is adapted to estimate the distribution of this quadratic form. Further, we have shown that asymptotically this bootstrap distribution is indeed the distribution of the test statistic under null hypothesis. The proposed methodology has been illustrated by simulation.

T. MIKOSCH

What do the sample autocorrelations of heavy-tailed processes tell us?

There is empirical evidence that log-returns of risky assets (exchange rates, stock indices, share prices, etc.) are heavy-tailed in the sense that they come from a model with infinite fourth moment. Such time series also exhibit some complicated dependence structure. This is indicated by the sample autocorrelation function of the series (the estimates are close to zero at almost all lags), its absolute values and its squares. The sample ACF of these transformed series have values different from zero even for large lags.

In the talk various time series models are considered which allow for modelling heavy tails and dependence. Such a class of models is given by stochastic recurrence equations $X_n = A_n X_{n-1} + B_n$, where (A_n, B_n) is an iid sequence. These equations are appropriate for describing classical time series models of finance, including $ARCH$ and $GARCH$ processes. Moreover, under mild conditions on B, X has a power law tail which explains the heavy tails observed for real-life financial data. We give a theory for the sample autocovariances and autocorrelations of such processes. We show that the sample autocorrelations can have a random limit or they estimate their deterministic counterparts at a rate which can be significantly slower than $\sqrt{n}$.

J. MØLLER

A review on perfect simulation for spatial processes

Since Propp and Wilson's (1996) seminal work on perfect simulation there has been an extensive interest in developing and applying their ideas in different contexts. Briefly, a perfect simulation is the output of some simulation procedure so that it follows the target distribution exactly. The main idea in the Propp-Wilson algorithm is to use coupling from the past in a clever combination with an updating rule for an ergodic Markov chain - Propp and Wilson (1996) assume the state space to be finite and equipped with some partial order so that the updating rule becomes monotone and there exist unique maximal and minimal elements of the state space. Propp and Wilson (1996, 1998) demonstrate that perfect simulation of the Ising model is feasible even at the critical temperature and for very huge lattices.

As pointed out by Fill (1998) the output of the Propp-Wilson algorithm is in general not independent of the termination time, so stopping runs before termination can cause a biased output. Under essentially the same assumptions (on the state space etc.) as in Propp and Wilson (1996), Fill introduces an alternative perfect simulation algorithm which is interruptible in the sense that the output is independent of the stopping rate.

Perfect simulation procedures seem particular useful for complex spatial models as used in statistical physics, spatial statistics, and stochastic geometry. In the talk I will review recent extensions of the ideas of Propp-Wilson and Fill to monotone and anti-monotone cases of spatial models defined on countable or continuous state spaces (including that for spatial point processes) and based on a number of papers by Mäggström, Kendall, van Lieshout, Neländer, Schladitz, Tönner and myself.

M. MOSER

Bootstrap order selection and M-estimation in linear autoregression

We present a bootstrap order selection procedure for the fit of a linear autoregression of finite order to observations from a linear autoregression of infinite order. The aim is to minimize the squared one-step-ahead prediction error expected in an independent copy of the data-generating process. A residual bootstrap is used to estimate that part of the quadratic loss due to the variation of the estimator.

To apply the bootstrap order selection criterion to M-estimation, we establish the asymptotic linearity of the corresponding score statistic and use a one-step Newton construction to give an asymptotic M-estimator. Some care is needed to adapt the M-estimator to the quadratic loss function. Finally, we discuss a natural generalisation of the notion of "asymptotic efficiency" introduced by Shibata (1980) to the case of M-estimation and prove the asymptotic efficiency of the proposed bootstrap order selection procedure.

G. NASON

Wavelet processes and adaptive estimation of the evolutionary wavelet spectrum

Joint work with R. von Sachs and G. Kroisandt.

In this work we define and study a new class of nonstationary random processes which are characterized by a representation with respect to a family of localized basis functions. Using non-decimated or "stationary" wavelets this generalizes the Cramér (Fourier) spectral representation of stationary time series. We provide a time-scale instead of a time-frequency decomposition and, hence, instead of thinking of scale in terms of "inverse-frequency" we start from genuine time-scale building blocks or "atoms".

Using our new model of "locally stationary wavelet" processes we develop a theory of how to define and estimate an "evolutionary wavelet spectrum". Our asymptotics are based on rescaling in time-location which permits rigorous estimation starting from a single stretch of observations of the process. The wavelet spectrum measures the local power in the variance-covariance decomposition of the process at a certain scale and (rescaled) time location.

To estimate the wavelet spectrum we use (corrected and appropriately smoothed) "wavelet periodograms". Further we suggest an inverse transformation of the smoothed wavelet periodogram that estimates a local autocovariance of the original stochastic process. We demonstrate our methods on simulated and baby ECG data and show the usefulness of our approach.

M.H. NEUMANN

Strong approximation of density estimators from weakly dependent observations by density estimators from independent observations

We derive an approximation of a density estimator based on weakly dependent random vectors by a density estimator built from independent random vectors. We construct, on a sufficiently rich probability space, such a pairing of the random variables of both experiments that the set of observations $\{X_1, \dots, X_n\}$ from the time series model is nearly the same as the set of observations $\{Y_1, \dots, Y_n\}$ from the i.i.d. model. With a high probability, all sets of the form $(\{X_1, \dots, X_n\} \Delta \{Y_1, \dots, Y_n\}) \cap ([a_1, b_1] \times \dots \times [a_d, b_d])$ contain not more than $O(\{[n^{1/2}\Pi(b_i - a_i)] + 1\} \log(n))$ elements, respectively. Although this does not imply very much for parametric problems, it has important implications in nonparametric statistics. It yields a strong approximation of a kernel estimator of the stationary density by a kernel density estimator in the i.i.d. model. Moreover, it is shown that such a strong approximation is also valid for the standard bootstrap and the smoothed bootstrap. Using the results we derive simultaneous confidence bands as well as supremum-type nonparametric tests based on reasoning for the i.i.d. model.

S. NOVAK

On extreme values

Let $X_1, X_2, \dots, X_n, \dots$ be a stationary sequence of random variables,

$$M_n = \max\{X_1, \dots, X_n\}$$

$u_n(\cdot)$ be a sequence of decreasing functions and

$$P(M_n \leq u_n(t)) \to e^{-t} \quad (n \to \infty).$$

Define the point process

$$N_n(A) = \sum_{i=1}^{n} \mathbb{1}\left\{\left(\frac{i}{n}, u_n^{-1}(X_i)\right) \in A\right\}.$$

So, we count the points when the pairs (i, X_i) hit some set A in the plain.

Necessary and sufficient conditions are suggested for "complete convergence" $N_n \Rightarrow N$, where N is a Compound Poisson point process. This allows to treat joint distribution of exceedances over few levels.

W. POLONIK

Conditional minimum volume predictive regions for stochastic processes

Joint work with Q. Yao

Motivated by interval/region prediction in nonlinear time series, we propose a minimum volume predictor (MV-predictor) for a general strictly stationary process. The MV-predictor varies with respect to the current position in the state space and has the minimum Lebesgue measure among all regions with the nominal coverage probability. We have established consistency, convergence rates, and asymptotic normality for both coverage probability and Lebesgue measure of the estimated MV-predictor under the assumption that the observations are taken from a strong mixing process. To this end, we have developed the asymptotic theory for a conditional empirical process indexed by sets, and for the corresponding (generalized) quantile process in a general setting. These results, including weak convergence to a P-bridge, and Bahadur-Kiefer type approximation rates, are also of independent interest. Simulation study with two time series models is conducted as illustrations.

S. RICHARDSON

Bayesian mixture estimation

Joint work with P. Green.

New methodology which makes use of *MCMC* methods, reversible jump *MCMC* introduced by Green (1995), that are capable of jumping between the parameter subspaces corresponding to different number of components in the mixture is described. The implementation of the method is discussed in the context of univariate normal mixtures with an unknown number of components, using a hierarchical pin model that offers an approach to dealing with weak pin information. The performance of the method is demonstrated on real and simulated data sets, with particular reference to criteria for posterior inference on the number of components.

P.M. ROBINSON

Nonstationary fractional processes: Asymptotic theory of quadratic forms and related statistics

Two problems are studied:

1. Approximation of sample covariances by averages of periodograms over a degenerating frequency interval around the origin, is studied in case of nonstationary time series

2. Functional central limit theorems for nonstationary fractional time series are given, including the vector case.

These problems have application in case of cointegration of nonstationary series, where the narrow-band periodogram averages are motivated by the possibility of stationarity.

H. RUE

Bayesian object identification

This paper addresses the image analysis problem of object recognition - locating and identifying an unknown number of objects of different types in a scene. The particular application in mind is the automatic labelling of cells in a microscope slide. High-level statistical image analysis has been the subject of much recent research activity (Baddeley & van Lieshout 1993, Grenander & Miller 1995). The former of these approaches advocates marked point processes as object priors; the latter approach is built around the use of deformable template models. In this paper elements of both approaches are combined to handle scenes containing variable numbers of objects of different types. The complexity of the posterior distribution of interest, together with the variable dimension of the parameter space, mean that reversible jump Markov chain Monte Carlo methods are required (Green, 1995). The naive application of these methods here leads to slow mixing; we propose three strategies to deal with this. The first two expand the model space by introducing an additional "unknown" object type and the idea of a variable resolution template. The third strategy is to include classes of updates which provide intuitive transitions between realisations containing different numbers of cells by splitting or merging nearby objects. A novel point estimator for the number of objects together with their locations, shapes and types is suggested and applied to an example of microscopy data.

R. VON SACHS

Estimating covariances of locally stationary processes: rates of convergence of best basis methods

Joint work with D.L. Donoho and S. Mallat.

Mallat, Papanicolaou and Zhang [Annals of Statistics, Feb. 98] recently proposed a method for approximating the covariance of a locally stationary process by a covariance which is diagonal in a specially constructed Coifman-Meyer basis of cosine packets.

In this paper we extend this approach to estimating the covariance from sampled data. Our method combines both wavelet shrinkage and cosine-packet best-basis selection in a simple and natural way. The resulting algorithm is fast and automatic. The method has an interpretation as a nonlinear, adaptive form of anisotropic time-frequency smoothing.

We introduce a new class of locally stationary processes which exhibits a form of inhomogeneous nonstationarity; our processes have covariances which typically change little from row to row, but might occasionally change abruptly. We study performance in an asymptotic setting involving triangular arrays of processes which are becoming increasingly stationary, and are able to prove rates of convergence results for our estimator. For this class of processes, the algorithm has advantages over traditional approaches like fixed-window-length segmentation followed by autocovariance estimation.

R.L. SMITH

Regression with long-memory errors

Consider the regression model

$$y_t = \sum_{k=1}^{K} \beta_k x_{k,t} + u_t, \quad 1 \le t \le T,$$

where $\{y_t\}$ is an observed series, $\{x_{k,t}\}$ are known regressors, and $\{u_t\}$ is a stationary time series with spectral density of form

$$f_u(\lambda) \sim c\lambda^{-2d}, \quad \lambda \downarrow 0, \quad 0 < d < \frac{1}{2}.$$

A special case of this model

$$y_t = \beta_1 + \beta_2 t + u_t$$

is proposed for studying trends in climatological time series when the alternative is a stationary series with long-range correlations.

We consider estimation methods based on the DFT

$$D_y(\lambda) = \sum_{k=1}^{K} \beta_k D_{x_k}(\lambda) + D_u(\lambda)$$

where $D_y(\lambda) = \frac{1}{\sqrt{2\pi T}} \sum_1^T y_t e^{i\lambda t}$ etc., and we restrict ourselves to small Fourier frequencies $\lambda_j = \frac{2\pi j}{T}$, $0 \leq j \leq n_T \ll T$. In the case $K = 0$ this method reduces to the "Gaussian semiparametric" method of estimation studied by P.M. Robinson (1995). By developing some new representation results for linear time series with regularly varying coefficients, we are able to cast further insight on the behaviour of $D_u(\lambda_j)$ for low Fourier frequencies, which helps to explain why Robinson's method works in that case.

For the model $y_t = \beta_1 + \beta_2 t + u_t$, however, there are unexpected difficulties. The estimation of β_2 depends critically on the behaviour of $D_u(\lambda_j)$ at very low frequencies, and the pathologies in that behaviour cannot be ignored. An alternative method, however, using the correct asymptotic covariances of the $D_u(\lambda_j)$ terms, appears to lead to satisfactory joint estimation of all the parameters.

M. SØRENSEN

Asymptotics for estimating functions for diffusions

Martingale estimating functions have turned out to be a useful tool for estimating parameters in models defined by stochastic differential equations when observations are made at discrete time points. This type of statistical problem is, for instance, relevant to the models used for pricing derivatives in modern mathematical finance.

A review is given of methods for contructing useful martingale estimating functions, including a construction based on eigenfunctions of the infinitesimal generator of the diffusion process. Then results based on large sample asymptotics for ergodic diffusions are presented on existence of a $\sqrt{n}$-consistent and asymptotically normal estimator. Finally, small dispersion asymptotics is considered. This type of asymptotics that is based on a stochastic Taylor expansion of the diffusion process can be used when the diffusion coefficient is small. The diffusion is not required to be ergodic or time-homogeneous. Also under this type of asymptotics, conditions ensuring the existence of a consistent and asymptotically normal estimator are given.

P. SOULIER

Log-periodogram regression of time series with long range dependence

Joint work with E. Moulines.

This paper discusses the use of fractional exponential models (Robinson (1990), Beran (1994)) to model the spectral density f of a stationary process. In the long range dependence context f writes as $f(x) = |1-e^{ix}|^{2d} f^*(x)$ where d is the differencing coefficient and f^* is a smooth function. Assuming Gaussianity and additional smoothness conditions on f^*, we prove asymptotic normality of the semi-parametric estimator of d, at a rate $n^{-\beta/(2\beta+1)}$ where n is the sample size and β is related to the smoothness of f^*. We conjecture that this rate is optimal over a relevant class of spectral densities. We also give an automatic criterion to choose the "smoothing" parameter p (the number of coefficients of the expansion of f^* over the Fourier basis to be estimated), based on the so called Mallow's C_p-statistics, developed by Tsybakov and Polyak (1989) in a classical nonparametric regression with iid errors setting.

W. STUTE

Statistical analysis of ARCH-M models

It is well known that ARCH-M models feature two important issues of financial time series:

1. a noise part guaranteeing conditional heteroscedasticity
2. a mean part guaranteeing that the conditional return is the same as for a riskless asset. See Duan, Math. Finance 5(1995), 13-32.

Interestingly enough the mean part is unobservable so that estimation of unknown parameters becomes a nontrivial problem. In this talk we propose and study in detail estimation of unknown parameters in an ARCH-M model.

R. WAAGEPETERSEN

Log Gaussian Cox processes

Log Gaussian Cox processes are Cox point processes where the logarithm of the random intensity surface is a Gaussian field. Log Gaussian Cox processes (LGCP's) provide flexible models for clustered point patterns and are furthermore appealing from a theoretical point of view. The product densities e.g. have simple expressions given in terms of the mean and covariance of the Gaussian field. This enables the construction of methods for parameter estimation and model checking.

Inference concerning the unobserved intensity surface is possible by application of Markov chain Monte Carlo. A Metropolis-Hastings adjusted Langevin algorithm is used to generate conditional simulations of the intensity surface given the observed point pattern. This Markov chain can easily be modified so that a geometrically ergodic Markov chain is obtained.

W. WEFELMEYER

Efficient estimators for semiparametric time series

Suppose we want to construct an efficient estimator for a functional of a semiparametric time series. The construction will depend heavily both on the functional and on the structure of the model. We illustrate this for two simple models and for two functionals. The models are the first-order autoregressive process with (1) i.i.d. innovations and (2) martingale increment innovations. The functionals are (1) the autoregression parameter and (2) the expectation of a function under the invariant law of the time series. The results on estimating an expectation are special cases of joint work with Anton Schick.

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