Helmut Schmidt Universität
Universität der Bundeswehr Hamburg

XITH Workshop Stochastic Models and their Applications

February 19-22, 2013 at the Helmut Schmidt University, Hamburg

Reliability Theory

Survival Analysis

Statistical Quality Control

Change Point Analysis/SPC/Surveillance

Spatial Statistics

Stochastic Procedures for Engineering and Natural Sciences

Einführung

Dies ist nun bereits der XI. Workshop „Stochastische Modelle und ihre Anwendungen“ (WSMA 2013) der Arbeitsgemeinschaft für „Stochastische Modelle in Zuverlässigkeit, Qualität und Sicherheit e. V.“. Gastgeber ist dieses Mal die Helmut-Schmidt-Universität, Universität der Bundeswehr Hamburg (HSU). All die Jahre bot dieser Workshop eine Bühne, um Ideen, Ergebnisse, Probleme und Anwendungen auf **dem** Gebiet der Stochastik zu präsentieren, **das** der AG ihren Namen gab. Wir hoffen, dass der diesmalige Workshop so erfolgreich wird wie seine Vorgänger. Auf den nächsten Seiten dieses Büchleins sind weitere Informationen bzgl. des Workshops versammelt.

Fächergruppe Mathematik und Statistik an der HSU

Introduction

This is already the XI$^{\text{th}}$ Workshop "Stochastic Models and their Applications" (WSMA 2013) of the Working Group "Stochastic Models for Reliability, Quality and Safety". It is hosted by the Helmut Schmidt University, the University of the Federal Armed Forces in Hamburg (HSU). All the time it offered a platform to present ideas, results, problems and applications in **that** field of stochastics **which** resembles the label of the Working group. We hope that the recent one will be as successful as the previous ones. On the next pages of this booklet some useful information are collected.

Institute of Mathematics and Statistics at the HSU

Hamburg, February 2013.

Miscellaneous

Workshop venue etc.

The workshop takes place in the Thomas Ellwein hall in the Mensa building of the HSU. The refreshments are served there too. Lunch on Wednesday and Thursday is offered at the „Offiziersheimgesellschaft“ (OHG).

Accessing the Internet

To access the internet during WSMA 2013 you can use the university's WiFi network. In your paperwork there is so called "Eventcamp Ticket" containing all the neccessary information.

- The net has SSID *event*.
- *Each morning* you must *renew* your net access by first visiting the gateway-page `http://internet.hsu-hh.de` and entering the activation key found on your ticket.
- For those sleeping on campus the code works in the guesthouse using a cable connection, too.

For those who have their machines configured to use *EDUroam*: Good news! It should just work!

If there are any problems don't hesitate to ask!

Some useful coordinates

- Local organizers:
  - Sven Knoth (room 1368, extension 3400[1], `knoth@hsu-hh.de`).
  - Doris Ehrich (room 2506, extension 3007, `doris.ehrich@hsu-hh.de`).
  - Detlef Steuer (room 1397, extension 2819, `steuer@hsu-hh.de`).
  - Miriam Seifert (room 1374, extension 3632, `miriam.seifert@hsu-hh.de`).
  - Dominik Wullers (room 1371, extension 3404, `wullers@hsu-hh.de`).
- Workshop URL: `http://WSMA2013.hsu-hh.de`
- Address of University Campus: Holstenhofweg 85, 22043 Hamburg

  (for google maps, open street map etc.)
- Bus routes to/from Campus: 10, 263, 261, E62

  URL of public transport is `http://www.hvv.de`
- Restaurant Fischerhaus URL: `http://www.restaurant-fischerhaus.de/`

[1] the full phone number would be then: +49 (0)40 6541 3400

Schedule

Wednesday, Feb 20

09:00 – 09:15	OPENING	
09:15 – 09:40	F Ziel, W Schmid *(EUV Frankfurt an der Oder)*	Estimation of periodic autoregressive heteroscedastic time series with seasonal variance
09:40 – 10:05	PG Ferrario *(U Stuttgart)*	Schätzung der lokalen Varianz für unzensierte und zensierte Daten
10:05 – 10:30	A Pepelyshev, A Steland *(RWTH Aachen)*	Estimation of the quantile function using Bernstein-Durrmeyer polynomials
10:30 – 10:55	N Albrecht *(TU Dresden)*	Asymptotic of quasi least squares estimators in irregular regression models
10:55 – 11:15	BREAK	
11:15 – 11:40	W Krumbholz, D Steuer *(HSU Hamburg)*	On Exact and Optimal Single Sampling Plans by Variables
11:40 – 12:05	W Kössler *(HU Berlin)*	Two-sided variable inspection plans for continuous distribution functions
12:05 – 12:30	W Kahle *(OvGU Magdeburg)*	Incomplete Repair in Degradation Processes
12:30 – 14:00	LUNCH	
14:00 – 14:25	S Schweer, C Weiß *(U Heidelberg, TU Darmstadt)*	Compound Poisson INAR(1) Processes: Stochastic Properties and Testing for Overdispersion
14:25 – 14:50	T Lazariv, W Schmid *(EUV Frankfurt an der Oder)*	On control charts for monitoring the variance of a time series
14:50 – 15:15	W Du, A Polunchenko, G Sokolov *(U Binghamton, USC Los Angeles)*	An accurate method to study the Shiryaev-Roberts detection procedure's run-length distribution
15:15 – 15:40	L Rabyk, W Schmid *(EUV Frankfurt an der Oder)*	EWMA control charts for long-memory processes
15:40 – 16:00	BREAK	
16:00 – 16:25	D Ambach, W Schmid *(EUV Frankfurt an der Oder)*	Forecasting Short-Term Wind Speed for the German-Polish Border
16:25 – 16:50	P Vetter, W Schmid *(EUV Frankfurt an der Oder)*	Efficient Approximation of the Spatial Covariance Function for large Spatial Datasets – Analysis of atmospheric CO_2 Concentrations
16:50 – 17:15	M Döring *(U Hohenheim)*	Change point estimation in regression models
17:15 – 17:40	A Prause, A Steland, M Abujarad *(RWTH Aachen)*	Estimation of Change-in-Regression-Models based on the Hellinger Distance for dependent data
17:40 – 18:00	BREAK	
18:00 – 19:00	WG MEETING	
19:30 – xx:xx	DINER AT PLAZA OR ...	

Thursday, Feb 21

09:00 – 09:50	S Knoth *(HSU Hamburg)*	Control Charts – Revisited
09:50 – 10:00	BREAK	
10:00 – 10:50	U Jensen *(U Hohenheim)*	Survival Analysis with applications in reliability theory
10:50 – 11:10	BREAK	
11:10 – 12:00	A Fasso *(U Bergamo)*	Stochastic models for spatio-temporal data: Inference and applications
12:00 – 13:40	LUNCH	
13:40 – 14:05	M Burkschat *(OvGU Magdeburg)*	Type-I censored sequential order statistics
14:05 – 14:30	JF Mai, M Scherer, N Shenkman *(TU München)*	Domain extendibility and limit laws of multivariate geometric distributions with no-aging characteristic
14:30 – 14:55	R Göb *(U Würzburg)*	Lot Sampling Distributions for Bounded Number of Nonconformities
14:55 – 15:15	BREAK	
15:15 – 15:40	E Liebscher *(HS Merseburg)*	Approximation of lifetime distributions using Anderson-Darling statistic
15:40 – 16:05	HJ Lenz *(FU Berlin)*	Data Fabrication – Unscrambling by Inlier and Outlier Tests
16:05 – 16:30	G Christoph *(OvGU Magdeburg)*	Edgeworth- und Cornish-Fisher-Entwicklungen
19:30 – xx:xx	DINER AT RESTAURANT FISCHERHAUS	

Friday, Feb 22

09:00 – 09:25	H Daduna, R Krenzler *(U Hamburg)*	An integrated model for performance and dependability analysis for an M/M/1/Infinity system
09:25 – 09:50	A Löpker, SK Bar Lev, W Stadje, O Kella *(HSU Hamburg, U Haifa, U Osnabrück, HU Jerusalem)*	Small-Time Behavior of Subordinators and connection to extremal processes
09:50 – 10:15	WD Richter *(U Rostock)*	Extreme value distributions for continuous $l_{n,p}$-symmetric sample distribution, Part I: Continuous $l_{n,p}$-symmetric distributions and their skewed versions
10:15 – 10:40	K Müller *(U Rostock)*	Extreme value distributions for continuous $l_{n,p}$-symmetric sample distribution, Part II: IFR-property
10:40 – 11:00	CLOSING	

Abstracts

Asymptotic of quasi least squares estimators in irregular regression models

Nadine Albrecht

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For a random vector $(X,Y) \in \mathbb{R}^2$ with the input variable X and response Y we investigate an estimator for the best L^2-approximation of Y by virtue of binary decision trees. The latter ones are of the shape $g(t,a,b) = a\mathbb{1}_{X\leq t} + b\mathbb{1}_{X>t}$, where t splits the feature space into two regions and in each of them constant predictions are given. Assuming the existence of a unique set of parameters (τ,α,β) which minimizes the mean squared error $\|Y - g(t,a,b)\|_{L^2}^2$, we define the least squares estimator $(\tau_n,\alpha_n,\beta_n)$ based on an i.i.d. sample $(X_i,Y_i)_{1\leq i\leq n}$. As is well known the regression curve $m(x) := \mathbb{E}(Y \mid X = x)$ is the best L^2-approximation. Depending on what we suppose for m, different and, contrary to conventional approaches, non-square root rates of convergence and non normal limit variables arise. If, for instance, m is a regression tree itself or as has been assumed in [1], satisfies particular smoothness requirements, the limit variables are maximizing points of certain two-sided stochastic processes like Poisson or Brownian motion with drift.

References

1. Banerjee, M. and McKeague, I. W. (2007). Confidence sets for split points in decision trees. *The Annals of Statistics* **35**(2), 543-574.

Forecasting Short-Term Wind Speed for the German-Polish Border

Daniel Ambach, Wolfgang Schmid

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Accurate short-term wind speed modeling and prediction is crucial for energy production. The importance of renewable power production is in terms of the energy turnaround a set goal. Developing short-term wind speed forecasting improvements provides helps to increase the productivity of wind energy. Moreover these models are used to optimize the overall energy supply particulary the feed-in of wind power. The wind speed forecast that is presented here, uses 10-minute data collected at several stations at the German-Polish border. The first model uses a multiple regression model with a daily periodicity, but assumes constant regression coefficients. According to the analysis of structural breaks we decide for second multiple regession model assuming that each regressor, including the daily periodicity, is varying over time. Moreover we implement a semiparalytic approach for giving more flexibility to the explanatory variables. Therefore a single index model with unknown link function is fitted to the varying regression coefficients. We discuss the results of well established approach of Haslett and Raftery (1989) as well as new methods like Ewing, Kruse and Schroeder (2006). Therefore we have to extend our model and apply an ARFIMA(p,d,q) – GARCH(P,Q) process to its highly correlated residuals. The most important finding is an enhancement of the forecasting accuracy up to one day that is directly related to our new short-term forecasting model.

References

1. R. T. Baillie, C.-F. Chung, and M. A. Tieslau (1995). Analyzing inflation by the fractionally integrated ARFIMA-GARCH model. *Journal of Applied Econometrics* **11**, 23-40.
2. J.-C. Bouette, J.-F. Chassagneux, D. Sibai, R. Terron, and A. Charpentier (2006). Wind in Ireland: long memory or seasonal effect? *Stoch Environ Res Risk Assess* **20**, 141-151.
3. B. T. Ewing, J. B. Kruse, and J. L. Schoeder (2006). Time series analysis of wind speed with time-varying turbulence. *Environmetrics* **17**, 119-127.
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6. H. Ichimura (1993). Semiparametric least squares (SLS) and weighted SLS estimation of single-index model. *Journal of Econometrics* **58**, 71-120.
7. J. W. Taylor, P. E. Mcsharry, and R. Buizza (2009). Wind power density forecasting using ensemble predictions and time series models. *IEEE Transactions on Energy Conversion* **24**, 775-782.
8. A. Zeileis (2001). strucchange: Testing for Structural Change in Linear Regression Relationships. *R News* **1**, 8-10.

Type-I censored sequential order statistics

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Sequential order statistics can be used to describe the successive failure times of components in a system, where failures may affect the performance of remaining components. If the observation of such failure times is stopped at a fixed threshold time, a Type-I censored sample is obtained. In the talk, conditional distributions of Type-I censored sequential order statistics are considered. In the particular case of an underlying exponential distribution, the distribution of corresponding spacings is examined. The results are used to derive distributions of maximum likelihood estimators in this setting.

Edgeworth- und Cornish-Fisher Entwicklungen

Gerd Christoph

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In den letzten Jahren sind Edgeworth- und Cornish-Fisher Entwicklungen in Anwendungsgebieten „angekommen“, insbesondere in Fragestellungen verbunden mit verbesserten Methoden zur Bestimmung des VaR (Value at Risk), aber auch zur Quantilbestimmung bei Verteilungen, die in der Energietechnik, bei Windströmungen und anderen technischen Gebieten auftreten. Dabei tritt nicht nur die Normalverteilung als Basis auf, sondern auch Student's t-, Chiquadrat- und F-Verteilung. Auf einige Beispiele wird besonders eingegangen.

An integrated model for performance and dependability analysis for an $M/M/1/\infty$ system

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In Operations Research applications queuing systems constitute an important class of models in very different settings. But in many situations those parts of a complex production system, which are modeled by queues, interact with other subsystems. These are often considered as environment for the queue. An important example is a unreliable manufacturing system (machine, modeled by a queuing system) whose service can be interrupted, will be repaired and resume service thereafter.

In [2] networks of queues with unreliable servers were investigated which admit product form steady states in twofold way: the joint queue length vector of the system (which in general is not a Markov process) is of classical product form as in Jackson's Theorem and the availability status of the nodes as a set valued supplementary variable process constitutes an additional product factor attached to the joint queue length vector.

We show that for the case of a single server with a more complex unreliability behavior than in [2] a product form steady state solution can be obtained as well.

We will analyze a queuing $M/M/1/\infty$-type service system which wears down during each service. As a consequence the failure probability increases. After the system breaks down it is repaired and thereafter resumes work as good as new. To prevent break downs, the system will be maintained after a fixed maximal number of services since the most recent repair or maintenance. During repair or maintenance the system is blocked, i.e., no service is provided and no new job may join the system. These rejected jobs are lost to the system. We will provide explicit steady state probability for this system which encompass both, the availability characteristics and the queue behavior. Using this results we discuss optimization of preemptive maintenance policies.

The steady state probability of this system shows decomposition properties. We analyzed such "loss"-system in a random environment in a more general version in [1], where we consider a single server system with infinite waiting room in a random environment. The service system and the environment interact in both directions: the environment process may block the service process, and the server, on the other side, may control the environment process by changing its state at service completion epochs.

Using the results in [1] it is possible to find solution for various new problems and more complex versions of old problems.

References

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2. C. Sauer and H. Daduna (2003). Availability formulas and performance measures for separable degradable networks. *Economic Quality Control* **18**, 165–194.

Change point estimation in regression models

Maik Döring

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In this talk we consider a simple regression model with a change point in the regression function. We investigate the consistency with increasing sample size n of the least square estimates of the change point.

It turns out that the rates of convergence depend on the order of smoothness q of the regression function at the change point. In the case of a discontinuity point of the regression function we have that the rate of convergence is n. In addition, it is shown, that for the discontinuity case the change point estimator converges to a maximizer of a random walk.

By increasing the order of smoothness up to an certain order q_t the rate decreases. In this case the change point estimator converges to a maximizer of a Gaussian process. Some simulations suggest that the limit distribution is not normal. But for $q > q_t$ we have a constant rate of $\sqrt{n}$ and the asymptotic normality property of the change point estimator.

At the certain order of smoothness q_t itself the rate of convergence of the change point estimator is $\sqrt{n \ln(n)}$. Interestingly, the limit distribution is also normal.

An accurate method to study the Shiryaev-Roberts detection procedure's run-length distribution

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Though measure-theoretic in origin, change-of-measure is a powerful technique ubiquitously used in Statistics and Probability. Particularly, it enabled the proof of a number of exact and asymptotic optimality results in the field of sequential change-point detection; such allied areas as statistical process and quality control have consequently benefited as well. To advance change-point detection and related areas further, we put the technique to a novel use: to develop a numerical method to study the in-control Run-Length distribution of the Shiryaev–Roberts (SR) detection procedure. The latter is an unheeded but capable competitor of the popular Cumulative Sum (CUSUM) chart and Exponentially Weighted Moving Average (EWMA) scheme. See, e.g., Shiryaev (1961, 1963); Roberts (1966). Specifically, the method is based on the integral-equation approach and the use of the change-of-measure ploy is to enable a higher rate of convergence (exact rate is provided). A tight bound on the method's error is supplied. The method is not restricted neither to a particular data distribution nor to a particular initial "head start" value. Flexible head start is using a martingale property of the SR detection statistic, it is also shown that the method's high accuracy is preserved even when the partition is rough. To conclude, we offer a case study to demonstrate the method at work. Specifically, assuming Gaussian observations, we employ the method to tabulate the SR's Run-Length's in-control average (i.e., the ARL), its standard deviation, and several quantiles. We also remark on extending the method's idea to other performance measures as well as to other control charts.

References

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Stochastic models for spatio-temporal data: Inference and applications

Alessandro Fassò

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Spatio-temporal data arise from a variety of application fields including environmental control, climate change, geo-marketing, spatial econometrics and computer experiments.

This lecture intends to address stochastic modeling issues for multiple continuous variables observed on continuous (geographical) space and discrete time. The approach proposed is based on hierarchical modeling and estimation is based on Gaussian maximum likelihood. These estimates are easily obtained also in relatively large problems thanks to a version of the EM algorithm which gives iteratively closed form forms for all parameters except spatial correlation, even in presence of missing data.

The lecture will give a brief introduction of temporal correlation and spatial correlation and kriging. After that it will focus on the spatio-temporal model called STEM which includes a linear coregionalization model over space and a Markovian dynamics over time. Examples will be taken from intervention analysis for spatio-temporal data, dynamic mapping for large datasets based on a varying coefficient model and human exposure distribution to airborne pollutants.

Schätzung der lokalen Varianz für unzensierte und zensierte Daten

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Die Fragestellung der Schätzung der lokalen Varianz, die in diesem Vortrag behandelt wird, wurde durch eine Anwendung im medizinischen Bereich motiviert. Wir nehmen an, dass ein Patient unter einer bestimmten Krankheit leidet, und der behandelnde Arzt den Krankheitsverlauf prognostizieren möchte. Von Interesse dabei ist es, die mittlere Überlebenszeit Y, aufgrund einer Beobachtung des d-dimensionalen Prädiktor-Zufallsvektors X – d.h. die Regressionsfunktion – zu schätzen. Die Vorhersagequalität der Regressionsfunktion wird global durch den sog. minimalen mittleren quadratischen Fehler und lokal durch die lokale Varianz angegeben. Ziel ist es, die lokale Varianz anhand geeigneter Schätzmethoden (Kleinste Quadrate, Lokale Mittelung, Nächste Nachbarn) zu schätzen.

Ein zusätzliches Problem dabei ist, dass die Informationen von Patienten, über die die Ärzte verfügen, oft nicht vollständig sind oder, selbst während der Behandlung, aus verschiedenen Gründen enden (Zensierung).

Mehrere Schätzer der lokalen Varianz werden angegeben, sowohl im unzensierten als auch im zensierten Fall, ihre Konsistenz wird gezeigt und die Konvergenzgeschwindigkeit wird unter Glattheitsvoraussetzungen ermittelt.

Die Leistung zweier gewählter Schätzer wird anhand Simulationen verglichen.

Lot Sampling Distributions for Bounded Number of Nonconformities

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Attributes sampling is an important inspection tool in areas like product quality control, service quality control or auditing. The classical item quality scheme of attributes sampling distinguishes between conforming and nonconforming items, and measures lot quality by the lot fraction nonconforming. A more refined quality scheme rates item quality by the number of nonconformities occurring on the item, e. g., the number of defective components in a composite product or the number of erroneous entries in an accounting record, where lot quality is measured by the average number of nonconformities occurring on items in the lot. Statistical models of sampling for nonconformities rest on the idealising assumption that the number of nonconformities on an item is unbounded. In most real cases, however, the number of nonconformities on an item has an upper bound, e. g., the number of product components or the number of entries in an accounting record. The present study develops two statistical models of sampling lots for nonconformities in the presence of an upper bound a for the number of nonconformities on each single item. For both models, the statistical properties of the sample statistics and the operating characteristics of single sampling plans are investigated. A broad numerical study compares single sampling plans with prescribed statistical properties under the bounded and unbounded quality schemes. In a large number of cases, the sample sizes for the realistic bounded models are smaller than the sample sizes for the idealising unbounded model.

Survival Analysis with Applications in Reliability

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Survival Analysis comprises models which were developed to estimate lifetime or survival distributions in medicine or biology. Obviously these models can also be applied in other fields like, for example, reliability. Lifetime data are often censored, which means that because of a limited observation period lifetimes of individuals can only be observed within certain intervals. Such situations with reduced information due to censoring effects are taken into account by regression models in Survival Analysis. The statistical inference of such point processes is carried out by modern tools of probability theory. Among these are martingale techniques which allow to model point and counting processes by means of intensities. Well known regression models which rely on martingale techniques are the Cox proportional hazards model and the additive model of O. Aalen. They are well suited if additional information should be entered into the model via covariates. In particular, in the standard Cox model the covariates are assumed to have constant influence. But some data sets exhibit deviations from this assumption. Therefore, we examine a Cox-type regression model with change points in some of the covariates. Estimates for these change points are derived and their properties are

investigated. Finally, the proposed method is applied to a real data set. This talk reviews some recent research with a personal perspective.

Incomplete Repair in Degradation Processes

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In the last years, there is an increasing number of papers concerning with incomplete (or general) repair models where the degree of repair is somewhere between a renewal (as good as new) and a minimal repair (as bad as old).

If a failure is the result of an underlying degradation process, then we have a natural interpretation of an incomplete repair: the repair action decreases the degradation level.

We consider the Wiener process with drift as a model of damage and degradation. A failure occurs when the degradation reaches a given level h first time. For preventive maintenance, inspections of the degradation are regularly carried out. If at inspection time the degradation is larger than a predefined level a, then the damage level is decreased. The costs of a maintenance depends on the degree of repair.

In the talk, we consider the problem of defining cost optimal maintenance policies.

Control Charts – Revisited

Sven Knoth

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SPC assembles methods (**control charts**, exactly) for monitoring statistical data. Useful synonyms are sequential change point detection, surveillance, **control charting**, continuous inspection, disorder problems, detection of abrupt changes, jump detection etc. The area was created in the 1920s by Walter Shewhart. There are many papers on theoretical aspects and on application. Dozens of software packages allow practitioners to utilize SPC on the shop floor. Quality engineers and auditors love to ask process engineers and shop floor personnel whether and how they are applying SPC procedures. During the last decade **control charts** experienced a renaissance in public health. CUSUM control charts were adopted to be applied for new data designs (keyword risk adjustment). This talk will give an overview about and some personal reflections on that field SPC.

Two-sided variable inspection plans for continuous distribution functions

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The ordinary variable inspection plans rely on the normality of the underlying populations. However, this assumption is vague or even not satisfied. Moreover, ordinary variable sampling plans are sensitive against deviations from the distribution assumption.

We present a short overview on variable and attribute sampling and suggest a variable sampling plan that can be used for arbitrary distribution functions with medium or long tails.

Nonconforming items occur in the tails of the distribution. This fact gives rise to the idea that the theory of extreme value distributions can be applied.

After a short introduction of extreme value distributions we show how the tails of the distribution can be approximated by a Generalized Pareto distribution. We estimate the fraction defective by Maximum Likelihood methods. The asymptotic normality of the ML estimates can be used for the construction of the inspection plans.

The sample sizes needed to satisfy the two-point conditions are much less than for attribute plans.

On Exact and Optimal Single Sampling Plans by Variables

Wolf Krumbholz, **Detlef Steuer**

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We deal with sampling by variables with two-way-protection in the case of a $N(\mu, \sigma^2)$ distributed characteristic with unknown σ. The LR sampling plan proposed by Lieberman and Resnikoff (1955) and the BSK sampling plan proposed by Bruhn-Suhr and Krumbholz (1990) are based on the UMVU- and the plug-in-estimator, respectively. For given p_1 (AQL), p_2 (RQL) and α, β (type I and II errors) we present an algorithm allowing to determine the optimal LR and BSK plans having minimal sample size among all plans satisfying the corresponding two-point-condition on the OC. An R (2012) package, ExLiebeRes (Krumbholz and Steuer, 2012), implementing that algorithm is provided to the public.

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On control charts for monitoring the variance of a time series

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Time series are widely used for modeling different types of processes in economics, finance, engineering and etc. The aim of Statistical Process Control (SPC) is to detect changes within a monitored process over time. For a long time the main applications of SPC have been in engineering. The most important tools of process control are control charts. The first control scheme was introduced by Walter Shewhart (1931). Nowadays control charts are one of the most important methods within quality control because they permit to reduce the production costs. In the last 20 years control schemes have been extended to other fields of science like, for instance, economics, medicine, environmental science, public health. Control charts are based on sequential analysis. Thus they permit to react on a change earlier then classical charts.

Early detection of changes in one or more parameters allows production processes to readjust the relevant process in time and thus minimize the rejection rate, generally to reduce the negative consequences of process variations. It is therefore of interest the so-called average run length (ARL), which measures the average number of observations until first alarm, but also to know the probability of false alarm rates caused by an appropriate choice of critical values. A disadvantage of Shewhart control chart is that its decision rule only makes use of a present sample and not of the preceding ones. For that reason the Shewhart chart has problems to detect small changes. Control schemes with a memory have been proposed by several authors. The most important approaches are Cumulative Sum (CUSUM) chart introduced by Page (1954) and the Exponentially-Weighted Moving Average chart by Roberts (1959).

Most of published literature has been focused on monitoring the mean behavior of the process. In my thesis the focus is on the surveillance of the variance of the underlying process. The variance plays a very important role in economy because it can be interpreted as the risk of an asset. Moreover, the underlying process is assumed to be a time series.

It has been shown that control charts for independent variables cannot be directly applied to time series (Montgomery and Mastrangelo (1991)), and it's necessary to take the structure of underlying process into account. Because of the complicated structure of the probability distribution of a stationary Gaussian process variance charts for such processes up to now have not been derived directly over the LR approach or the SPRT. The starting point of the considerations is usually an independent normal sample. The CUSUM scheme for independent variables is derived and after that the same recursion is applied to stationary processes as well. It is obvious that this procedure is unsatisfactory.

There are only few published papers dealing with this problem (Chen and Gupta (1997), Shipper and Schmid (2001)). In these papers the same structure of the variance charts for independent samples is used and the underlying time series structure is only taken into account for the calculation of the control limits. In the thesis it is planned to derive control procedures by using the likelihood ratio approach, the sequential probability ratio test (SPRT), the Shiryaev-Roberts approach (SR), as well as the corresponding generalized procedures for time series. By making use of the structure of the underlying process we expect to get better control schemes than the present ones. Within simulation study all proposed schemes will be compared with each other under the assumption that underlying process is autoregressive process of order 1 (AR(1)). As a measure of performance the average run length (ARL) is used, which is the average number of observations until the chart gives a signal.

Data Fabrication –
Unscrambling by Inlier and Outlier Tests

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Fakes of experimental data in the commercial, medical or science domains are not novel activities. They happen again and again world wide, and some of them in German speaking countries are recently reported by the media.

A long history in Economics has model hunting based on sequential testing of model candidates while ignoring the work of *Sonnenberg* (1985) on "sequential testing" and others. This can be viewed as a more subtle way of unsound empirical research due to an induced model selection bias.

No longer not honest but criminal is **data fabrication**. Here running designed experiments or making state space observations and measurements causing large time and cost budgets are substituted by **fitting numbers**. In industry data fabrication is used for covering red numbers, getting bank credits by a bluff or making unfair profits.

The vital economical, scientific and social question is about the role of Statistics in this field. Are there methods to uncover data fabrication with reasonable precision (low classification error of 1st kind) for protecting innocent stage holders (low classification error of the 2nd kind).

Evidently, the Theory of **robust Multivariate Statistics** (Estimation and Testing) has something to offer.

We report about some few cases and present first solutions.

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Approximation of lifetime distributions using Anderson-Darling statistic

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The distribution of lifetime data differs significantly from all common distribution models frequently in applications. Sometimes it is hard to find an appropriate distribution model at all. In this case it happens that all hypotheses of known distribution models are rejected by usual significance tests. So it makes sense to consider the problem of best approximation of the underlying distribution by a given parametric family of distributions as an alternative. In the talk we introduce a measure of goodness-of-approximation. We search for the distribution from the parametric family which approximates best the distribution of the data.

The first part of the talk deals with approximations of the distribution by use of the *Anderson-Darling (AD) divergence* which is defined by

$$A(F,G) = \int_0^{+\infty} \frac{\big(F(x)-G(x)\big)^2}{G(x)\big(1-G(x)\big)}\,\mathrm{d}G(x)\,.$$

This divergence measure gives more weight to the tails of the distribution than other commonly used measures, Kolmogorov-Smirnov one for example. Using AD-divergence one can identify a special type of lifetime distribution quite well.

Let $T_1,\ldots,T_n$ be a sample of lifetimes having a distribution function F and a density f. We consider a family of models $\mathcal{M} = \{F_\theta : \theta \in \Theta\}$, where F_θ is the distribution function depending on parameter θ. It is assumed that $F \notin \mathcal{M}$. The empirical version of the Anderson-Darling-divergence, i.e. the divergence of the empirical distribution function from the model family is given by

$$A(F_n,F_\theta) = -n - \sum_{i=1}^{n} \frac{2i-1}{n}\Big(\ln F_\theta(T_{(i)}) + \ln\big(1-F_\theta(T_{(n+1-i)})\big)\Big)\,.$$

In this formula $T_{(1)},\ldots,T_{(n)}$ is the ordered sample. We have to estimate the parameter which gives the best approximation, i.e.

$$\theta_0 = \arg\min_{\theta\in\Theta} A(F,F_\theta)\,.$$

It should be pointed out that θ_0 depends heavily on the approximation measure. There is no "true parameter". The corresponding estimator $\hat\theta_n$ is defined as an approximate minimum distance estimator satisfying

$$A(F_n,F_{\hat\theta_n}) \leq \arg\min_{\theta\in\Theta} A(F_n,F_\theta)+\varepsilon_n$$

where $\{\varepsilon_n\}$ is a sequence of random variables with $\varepsilon_n \to 0$ *a.s.* We consider such estimators $\hat\theta_n$, since the result of using a numerical minimisation algorithm is as a rule only an approximate minimiser. Given a real number $M>0$, we want to test the hypothesis

$$H_0: A(F,\mathcal{M}) \leq M, \quad H_1: A(F,\mathcal{M}) > M\,.$$

The advantage of this setup is that $A(F_n,F_{\hat\theta_n})$ is asymptotically normally distributed instead of a rather complicated type of distribution in the situation of goodness-of-fit. Since the AD-statistic $A(F_n,F_\theta)$ is a U-statistic up to a certain factor, the proof for the asymptotic distribution can be done by utilising central limit theorems for U-statistics. Moreover, we present a test for the significance of differences of divergence values from two different model classes.

In the second part of the talk we consider the situation of a censored sample. Let F_n^* be the Kaplan-Meier estimator of the distribution function. Analogously to complete samples, the asymptotic normality of the approximation measure

$$\bar A(F_n^*,F_\theta) = \int_0^\tau \frac{\big(F_n^*(x)-F_\theta(x)\big)^2}{F_\theta(x)\big(1-F_\theta(x)\big)}\,\mathrm{d}F_\theta(x)$$

was proved and is discussed in the talk.

The last part of the talk is devoted to results from simulations and real datasets. We show the advantages of the AD-statistic over other approaches. We show that the AD-statistic can be used for model selection. A typical situation in lifetime data analysis is that the analyst has models like Weibull distribution, LogNormal one, Gamma one or inverse Gaussian distribution in mind and wants to select the most appropriate one. This can be done by selecting that distribution which gives the smallest value of $A(F_n,F_{\hat\theta_n})$.

Small-Time Behavior of Subordinators and connection to extremal processes

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Based on a result in a 1987 paper by Bar-Lev and Enis, we show that if Y_t is a driftless subordinator with the additional property that the tail of the Levy-measure behaves like $-c\log(x)$ as x tends to zero, then Y_t^{-t} tends weakly to a limit having a Pareto distribution as $t\to 0$. We investigate several equivalent conditions to ensure this convergence and present examples of processes that fulfill these conditions. We then prove that one can extend these results to a statement about convergence of processes and show that under the above conditions $-t\log(Y_t)$ tends weakly to what is called an extremal process as $t \to 0$. Moreover, we study for more general results concerning the convergence of $g_t(Y_t)$ for appropriate classes of processes Y_t and classes of functions g_t, with the objective to obtain simple conditions on Y_t, stated in terms of its the Laplace transform. For example, if $g_t(x)$ is increasing, positive and differentiable and $g_t'(x)/g_t(x)$ tends to infinity as $t \to 0$, then $g_t(Y_t) \to Y$ weakly iff $\psi_t(1/g_t^{-1}(u))$ tends to $P(Y \le u)$ as $t \to 0$.

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Domain extendibility and limit laws of multivariate geometric distributions with no-aging characteristic

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The discrete multivariate lack-of-memory (LM) property is extended to random vectors with rational components. A set of necessary and sufficient conditions subject to which the domain of a d-variate geometric distribution satisfying the local LM property can be extended to $(k^{-1}\mathbb{N})^d$, for some $k \in \mathbb{N}$, without violating the LM structure, is derived. The resulting distribution is proved to be unique and is referred to as the k-domain extension. On the one hand, the narrow-sense geometric distribution yields to be k-domain extendible for all $k \in \mathbb{N}$. On the other hand, a multivariate geometric distribution which is k_n-domain extendible for some increasing sequence $\{k_n\}_{n\in\mathbb{N}}$ is geometric in the narrow sense. The k-domain extension of a multivariate geometric distribution is shown to converge weakly to a Marshall-Olkin distribution as $k \to \infty$. Extending the domain of a geometric distribution is relevant for practical applications when the time grid has to be refined without violating the initial dependence structure. Examples are multi-period models in portfolio credit risk.

Extremwertverteilungen über stetiger $l_{n,p}$-symmetrischer Grundgesamtheit; Teil II: IFR-Eigenschaft

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(1) Geometrische Maßdarstellung und Maximumverteilung

Aufbauend auf Vortrags-Teil I wird hier nun die Anwendung der geschieften bzw. ungeschieften stetigen $l_{2,p}$-symmetrischen Verteilungen und speziell der entsprechenden zweidimensionalen geometrischen Maßdarstellung demonstriert. In diesem ersten Abschnitt erfolgt die Herleitung einer Integraldarstellung der exakten Verteilungsfunktion der Maximumstatistik über stetiger $l_{2,p}$-symmetrischer Grundgesamtheit auf der Grundlage der geometrischen Maßdarstellung. Anschließend wird unter Anwendung der Integralregel von Leibniz eine Integraldarstellung für die exakte Dichtefunktion dieser Statistik aus der Verteilungsfunktion hergeleitet. Beide Funktionen sind in [5] angegeben. Die Ergebnisse dieser Arbeit erweitern und verallgemeinern jene in [3] hinsichtlich der Klasse der betrachteten Stichprobenfunktionen und in Bezug auf den hier beliebig positiv wählbaren Parameter p. Weiterhin wird in diesem Abschnitt ein Bezug zur Verteilung der Minimumstatistik durch Ausnutzung der $l_{2,p}$-Symmetrie der Grundgesamtheit hergestellt.

(2) Maximumverteilung als geschiefte, stetige $l_{1,p}$-symmetrische Verteilung

In [4] wurde gezeigt, dass die Ordnungsstatistiken über austauschbar-normalverteilter Grundgesamtheit der sogenannten abgeschlossenen geschieften Normalverteilung folgen. Speziell für den zweidimensionalen Fall wurde gezeigt, dass die Extremwertstatistiken über normalverteilter Grundgesamtheit jeweils einer eindimdimensionalen geschieften Normalverteilung folgen. Im zweiten Abschnitt dieses Vortrags wird nun die zuvor erhaltene exakte Dichtefunktion entsprechend [2] in die Darstellung einer Dichtefunktion einer geschieften stetigen $l_{1,p}$-symmetrischen Verteilung überführt. Letztere Verteilung stellt ihrerseits einen Spezialfall jener Verteilungen dar, welche in [1] eingeführt wurden.

(3) IFR-Eigenschaft

In der bereits genannten Arbeit [4] wurde außerdem gezeigt, dass die Dichtefunktionen extremaler Ordnungsstatistiken über austauschbar-normalverteilter Grundgesamtheit logarithmisch konkav sind. Im Anschluss an die vorherigen Abschnitte erfolgen nun Betrachtungen zur IFR-Eigenschaft unter Ausnutzung der Verteilungsfunktion der Maximumstatistik in den zwei zuvor bestimmten Darstellungen. Schließlich wird der Spezialfall der p-verallgemeinerten Normalverteilung betrachtet, für den eine ganz allgemeine Aussage über die Verteilungs- bzw. Dichtefunktionen von Ordnungsstatistiken auf die Dichtefunktion in der Darstellung aus Abschnitt 2 führt. Diese Vorgehensweise ist anwendbar, da im Falle der p-verallgemeinerten Normalverteilung die Unabhängigkeit der Komponenten aus der im allgemeinen vorausgesetzten Unkorreliertheit folgt.

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Estimation of the quantile function using Bernstein-Durrmeyer polynomials

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Bernstein and Bernstein-Durrmeyer polynomials are convenient tools for smoothing functions defined on a finite interval. For estimation of probability distributions, Bernstein polynomials have been studied in a number of papers. Cheng (1995) and Perez and Palacin (1987) investigated the estimation of the quantile function, while Babu, Canty, and Chaubey (2002) obtained results for estimating the distribution function. Density estimation based on Bernstein-Durrmeyer polynomials, dating back to the seminal work of Durrmeyer (1967) has been studied by Ciesielski (1988). Rafajłowicz and Skubalska-Rafajłowicz (1999) investigated related estimators for nonparametric regression and obtained results on optimal convergence rates.

In our work we study quantile estimation using Bernstein-Durrmeyer polynomials in terms of its MSE and IMSE including rates of convergence and propose an improved estimator based on an error-correction approach for which a general consistency result is established. Specifically, the *Bernstein-Durrmeyer estimator* of the quantile function is given by

$$\widehat{Q}_{m,N}(x) = (N+1)\sum_{i=0}^{N} \tilde{a}_i B_i^{(N)}(x), \qquad x \in [0,1],$$

with $\tilde{a}_i = \int_0^1 Q_m(x) B_i^{(N)}(x)dx$, where $B_i^{(N)}(x) = \frac{N!}{i!(N-i)!}x^i(1-x)^{N-i}$, $i = 0,\ldots,N$, and $Q_m(x)$ is the empirical quantile function for a sample $X_1,\ldots,X_m$.

A crucial issue is how to select the degree of Bernstein-Durrmeyer polynomials. We propose a novel data-adaptive approach that controls the number of modes of the corresponding density estimator and show its consistency including an uniform error bound as well as its limiting distribution. The finite sample properties are investigated by a Monte Carlo study. Finally, the results are illustrated by an application to photovoltaics (Steland, Zähle, 2009).

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Estimation of Change-in-Regression-Models based on the Hellinger Distance for dependent data

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We study minimum Hellinger distance estimation (MHDE) based on kernel density estimators for a large class of parametric regression models including models with a change in the regression function. To be more precise we consider for an observed random sample (X_0, Y_0), (X_1, Y_1), ..., (X_n, Y_n) of bivariate random vectors, whose density belongs to the parametric family $\mathcal{F} = \{p_\theta : \theta \in \Theta\}$ with $\Theta \subset \mathbb{R}^l$, the (nonlinear) regression model $Y_t = g_{\theta_0}(X_t) + \sigma_{\theta_0}(X_t)\varepsilon_t$, $t \geq 0$. If we take the function g as $g_\eta(x) = \widetilde{g}_{\eta_1}(x) + [\widetilde{g}_{\eta_2}(x) - \widetilde{g}_{\eta_1}(x)]\mathbf{1}_{\{x \geq c\}}$, $\eta = (\eta_1, \eta_2)$, with $c \in \mathbb{R}$ known we get an example for a model with a change in the regression function. As an example of use for this model one could think of the production costs of a product which get lower after a certain amount of goods has been produced. Moreover, also the (non-linear) autoregressive model of order one can be considered as a special case of the general regression model.

The idea of the Minimum Hellinger distance approach now is to minimize the L_2 distance between the square roots of $p_\theta(x, y)$ and some nonparametric density estimator $\widehat{q}_n(x, y)$, which in this work is chosen to be a two dimensional kernel density estimator.

It is shown that consistency and asymptotic normality of the MHDE basically follow from the uniform consistency of the density estimate and the validity of the central limit theorem for its integrated version. Those conditions hold true for i.i.d. as well as for strong mixing observations under fairly general conditions. In the mixing case these conditions include smoothness conditions on the kernel functions and the joint density of (X_0, Y_0) as well as a certain decay of the α-mixing coefficients. As an important difference to the case of univariate observations, the asymptotic normality of the MHDE can only be shown when correcting with a certain bias term. This bias term can eiter be random or deterministic and is a consequence of conflicting orders of convergence of certain terms that appear in the decomposition of $\sqrt{n}\left(\widehat{\theta}_n - \theta\right)$. To the best of our knowledge no other MHD results have been developed for multivariate dependent data for our class of parametric regression models yet, i.e. for time series.

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EWMA control charts for long-memory processes

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Different types of the processes (in chemistry, engineering, economy, environmental sciences and etc.) can be modeled by using time series. The statistical process control (SPC) is used for detection of the structural deviations in a process over time. The main tools of the SPC are control charts.

In the 20s and 30s of the 20th century Walter Shewhart introduced various control charts for the mean and for the variance (e.g. Shewhart (1931)). A disadvantage of these charts was the fact that they didn't have memory. Control charts with a memory were introduced by Roberts (1959), the exponentially weighted moving average (EWMA) control chart, and by Page (1954), the cumulative sum (CUSUM) control chart, respectively. In this control charts the impact of the past values is controlled by additional parameters. Many papers about control charts for time series have been published within last years. Most of these papers are dealing with the surveillance of the mean behavior of a time series.

For a long time it was assumed that the observations are independent and identically distributed. Unfortunately, this assumption often is not valid in many manufacturing or environmental processes. To deal with such kind of data, various control charts have been discussed and developed (Lu and Reynolds (1999)).

Much research work has been devoted to the performance of control charts applied to correlated data following autoregressive moving average (ARMA) models. A lot of modified versions of Shewhart, EWMA and CUSUM control charts have been developed for such kind of data. These control charts have been found to be effective for monitoring stationary processes with autocorrelation functions decreasing exponentially and in suitably fast manner. Such processes are called short-memory processes. However, many empirically observed time series such as stock returns, wind speed, hydrological time series have been found to have autocorrelation functions decreasing slowly by hyperbola. Such processes are called long-memory processes. The class of autoregressive fractionally integrated moving average (ARFIMA) processes having fractional differencing parameter d is often used to characterize long-range dependent behavior. Since there are a lot of time series following ARFIMA models, they are of natural interest in quality control research.

In this paper, we investigate the performance of the exponentially weighted moving average (EWMA) control chart for detecting mean shifts in long-range dependent processes. Paper consists of theoretical and simulation studies.

First we introduced the autoregressive fractionally integrated moving average (ARFIMA) processes. Then we gave a short description of control charts for dependent data. There are two different types of the statistical control charts for dependent data - residual and modified control charts. The first ones (e.g., Alwan and Roberts (1988), Harris and Ross (1991), Montgomery and Mastrangelo (1991), Wardell et al. (1994a,b)) are based on the standard schemes that are applied to the (empirical) residuals of suitable time series model. For getting the modified charts (e.g., Nikiforov (1975), Vasilopoulos and Stamboulis (1978), Yashchin (1993), Schmid (1995, 1997a,b)) the stopping rule (variance term, control limit) of the control charts is modified.

Therefore, theoretical results of the modified and residual EWMA control chart for ARFIMA processes are given in theoretical part. The performance of the modified and residual EWMA control charts for detecting mean shifts in long-range dependent data is analyzed by simulations. As a measure of performance the average run length (ARL) was used. The ARL denotes the average number of the observations (or samples) from the beginning of observation until the scheme signals. The target process is given by autoregressive fractionally integrated moving average (ARFIMA) process. ARFIMA(0,d,0), ARFIMA(1,d,0), ARFIMA(0,d,1) and ARFIMA(1,d,1) processes are considered. The ARLs are computed for the modified and residuals EWMA control charts for ARFIMA processes.

Extremwertverteilungen über stetiger $l_{n,p}$-symmetrischer Grundgesamtheit; Teil I: Stetige $l_{n,p}$-symmetrische Verteilungen und ihre geschieften Versionen

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(1) Stetige $l_{n,p}$-symmetrische Verteilungen

Zahlreiche klassische exakte Verteilungs-Aussagen der Mathematischen Statistik wurden unter der Annahme formuliert, dass die Grundgesamtheit einer multivariaten Normalverteilung folgt oder einer anderen, mathematisch ebenfalls gut beherrschten mehrdimensionalen Verteilung, wie etwa der Exponential- oder der Laplace-Verteilung.

Ausgehend von einem auf der Euklidischen Einheitssphäre gleichmäßig verteilten Zufallsvektor und einer von ihm unabhängigen positiven Zufallsgröße wurde durch deren multiplikative Verknüpfung die Klasse der sphärischen oder $l_{n,2}$-Norm symmetrischen Verteilungen konstruiert, siehe etwa in [3].

Der so gewonnenen stochastischen Darstellung einer Familie von Zufallsvektoren entspricht eine geometrische Darstellung der zugehörigen Verteilungen. Diese wurde in [7] angegeben. Zugleich führte eine beispielhafte erste Anwendung dieser geometrischen Maß-Darstellung zur g-Verallgemeinerung der Chiquadrat-Verteilung, wobei die Dichte-generierende Funktion g je nach Anwendungsgebiet zur Modellierung sehr leichter oder auch sehr schwerer ein- und mehrdimensionaler Verteilungsenden genutzt werden kann.

Stochastische Vektor- und geometrische Maß-Darstellungen erlauben es auch im Falle elliptisch konturierter Grundgesamtheit, in ähnlicher Weise exakte Verteilungs-Aussagen für zahlreiche Statistiken herzuleiten.

Eine analoge stochastische bzw. geometrisch-maßtheoretische Konstruktion der Klasse der simplizial konturierten Verteilungen als einer der möglichen Verallgemeinerungen der multivariaten Exponentialverteilung wurde in [2] und [5] durchgeführt und die entsprechende geometrische Maßdarstellung auf unterschiedliche statistische Fragestellungen angewendet. Diese Resultate können unmittelbar auf die Klasse der $l_{n,1}$-Norm symmetrischen Verteilungen übertragen werden, wie auch Darstellungen $l_{n,2}$-Norm symmetrischer Verteilungen an asymmetrische Situationen, etwa für positive Zufallsgrößen, angepasst werden können.

Eine Verteilungsklasse, welche die $l_{n,1}$-Norm und die $l_{n,2}$-Norm symmetrischen Verteilungen sowie auch die p-verallgemeinerten Normalverteilungen (oder: power exponential distributions) als Spezialfälle enthält, ist die u.a. in [8] diskutierte Klasse der $l_{n,p}$-Norm symmetrischen Verteilungen, $p \geq 1$. Diese basiert wesentlich auf einer verallgemeinerten Gleichverteilung auf der $l_{n,p}$-Sphäre, deren Definition im ersten Abschnitt dieses Vortrages zunächst formal über die $l_{n,p}$-Normierung eines p-verallgemeinert-normalverteilten Vektors erfolgt. Über eine entsprechende stochastische Vektor-Darstellung wird anschließend die Klasse der $l_{n,p}$-Norm symmetrischen Verteilungen im ersten Abschnitt dieses Vortrages eingeführt.

(2) Geometrische Maßdarstellung

Im zweiten Abschnitt wird dann die p-verallgemeinerte Gleichverteilung auf der Grundlage eines verallgemeinerten Oberflächen-Inhaltsbegriffs geometrisch- maßtheoretisch charakterisiert und zur Herleitung einer geometrischen Maß-Darstellung herangezogen. Die dabei zum Einsatz kommende Geometrie ist vom Standpunkt der metrischen Geometrie aus eine nicht-Euklidische Geometrie zu nennen. Eine erste beispielhafte Anwendung dieses Resultates führt zu einer weiteren (p,g)-Verallgemeinerung der Chiquadrat-Verteilung. Die geometrische Maß-Darstellung der $l_{n,p}$-Norm symmetrischen Verteilungen kann als nicht-Euklidische Verallgemeinerung der Indivisiblenmethode von Cavalieri und Torricelli aufgefasst werden. Ein gewisser Überblick über ihre im Falle $p = 2$ bereits realisierten zahlreichen Anwendungen wurde in [8] gegeben.

(3) Geschiefte $l_{n,p}$-symmetrische Verteilungen

Die Klasse der geschieften Normalverteilungen erlaubt bei gegebener Datenmenge eine wesentlich flexiblere Modellbildung als die Normalverteilung und hat bereits zahlreiche Anwendungen erfahren, siehe hierzu etwa in [4]. In [6] wurden Zusammenhänge zwischen den Verteilungen von Ordnungsstatistiken über austauschbar-normalverteilter Grundgesamtheit und mehreren geschieften Versionen der Normalverteilung festgestellt. Dies motiviert für Abschnitt drei dieses Vortrags die Vorstellung der Klasse der geschieften $l_{n,p}$-symmetrischen Verteilungen, welche wiederum die Klasse der geschieften Normalverteilungen als einen Spezialfall (für $p = 2$) enthält und unlängst in [1] eingeführt wurde.

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Compound Poisson INAR(1) Processes: Stochastic Properties and Testing for Overdispersion

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The study of integer-valued time series has attracted a lot of attention in recent years. In particular, the *in*teger-valued *a*uto*r*egressive model of order 1 (INAR(1) model) as introduced by McKenzie (1985) was studied in several papers. In many applications, the innovations of the INAR(1) process are assumed to be Poisson distributed, which leads to a Poisson marginal distribution of the process. An important characteristic of the Poisson distribution is that it is equidispersed, i. e., its mean and variance are equal. It should be noted, however, that many real-world data examples exhibit overdispersion (i. e., the variance is greater than the mean). In order to allow for overdispersion of the process, several modifications of INAR(1) processes have been suggested. While some focus on possible modifications of the thinning operation used for defining the INAR(1) model (Weiß, 2008), the approach taken here focuses on the distribution of the innovations, by considering the larger class of compound Poisson (CP) distributions.

After a brief survey of important properties and special cases of the CP-distribution, we consider first the INAR(1) model in general and derive closed-form expressions for the joint moments up to order 4, thus generalizing a result of Weiß (2012). Then we consider the compound Poisson INAR(1) model for time series of overdispersed counts, and we derive explicit results for the k-step-ahead distribution as well as for the stationary distribution. It is argued that a CPINAR(1) process is strongly mixing with exponentially decreasing weights. This result is utilized to design a test for overdispersion in INAR(1) processes and to derive its asymptotic power function. We conclude with an application of our results to a real-data example and with a study of the finite-sample performance of the test.

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Efficient Approximation of the Spatial Covariance Function for large Spatial Datasets – Analysis of atmospheric CO_2 Concentrations

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Gaussian linear mixed effects models have been widely used in the spatial statistical analysis of environmental processes. However, parameter estimation and kriging predictions involve the inversion of the $n \times n$ covariance matrix of the data process with n observations, which can be compuationally very demanding in a large data setting and requires $O(n^3)$ operations. This article is focused on recently developed approaches for the efficient approximation of the spatial covariance function, namely Fixed Rank Kriging, Covariance Tapering and their combination in a full scale approximation. It is shown how the computational costs can be reduced by either introducing sparseness to the covariance matrix or by requiring only the inversion of a low-rank covariance matrix. In a second part the approaches are applied in a real dataset of 12 000 remotely sensed carbon dioxide concentrations, obtained from the Atmospheric Infrared Sounder of NASA's "Aqua" satellite on the 1st of May 2009. Kriging predictions and variances are computed for each approach on a regular grid with 250 000 prediction locations. The predictive performance is further evaluated through a series of cross-validation experiments, highlighting the advantages and drawbacks of the different approaches, in particular it is investigated how they behave in regions with plenty of data and in situations, when there is only a sparse data density.

Estimation of periodic autoregressive heteroscedastic time series with seasonal variance

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We consider a general periodic autoregressive heteroscedastic time series model. It nests models like the periodical ARMA-GARCH model or weak periodic ARMA (PARMA) model. Because every parameter is allowed to vary with seasonal structure the general model is very flexible and allows application in many statistical areas. For the periodic parameter classical, Fourier and B-spline estimation methods were analysed. Maximum Likelihood-estimation such as non-parametric estimation techniques are presented and discussed. Moreover applications to different environmental and financial time series are shown.

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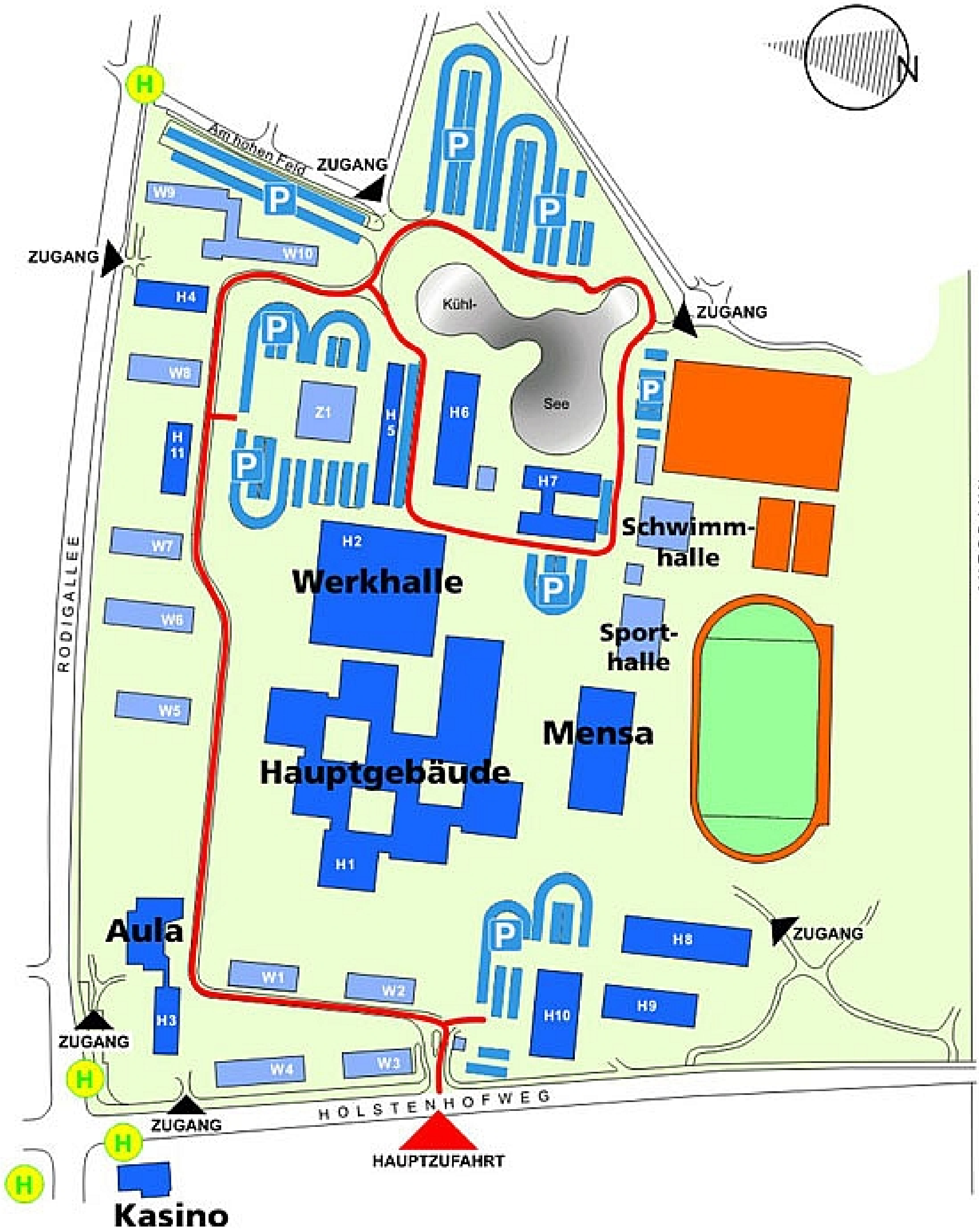

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