GOODNESS-OF-FIT & CHANGE-POINT PROBLEMS

25-29 August 2023
Skukuza
South Africa

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Contents

Welcome

A very warm welcome to the 6th international workshop on Goodness-of-fit and Change-point problems (GOFCP) held in the Kruger National Park, South Africa.

While the event is normally only hosted every two years, the trend was forced to change due to the pandemic. This year we return to hosting the workshop on an odd-numbered year!

The main themes of the event include classical goodness-of-fit (GOF) testing and change-point (CP) analysis; Fourier methods for GOF testing and CP detection; GOF and CP analyses in econometrics, time series, functional and high-dimensional data, and survival data.

The single-session scientific programme with invited oral presentations of all 29 presenters is provided in this document along with short abstracts for each talk.

We would like to thank the Scientific Programme Committee for their work in inviting and securing such an amazing ensemble of academics for these workshops, the members of the organising committee for all of their efforts towards making this event possible, the North-West University for the funding they provided, and the Skukuza lodge hotel for the arrangements they have made for this occasion.

Finally, we thank all of the delegates for attending and sincerely hope that everyone will enjoy the presentations of the workshop as well as their stay in the Kruger Park. We happily encourage all delegates to make use of the opportunity to experience the natural beauty afforded by the surroundings we have chosen this year by going on any of the scheduled game drives or other planned activities.

Enjoy your stay!

GOFCP2023 Local Organising Committee

Scientific Programme Committee (SPC)

Ingrid Van Keilegom (KU Leuven)

Natalie Neumeyer (University of Hamburg)

Valentin Patilea (ENSAI, France)

María Dolores Jiménez-Gamero (Universidad de Sevilla)

Sponsors: North-West University: Pure and Applied Analytics (PAA), School for Mathematical and Statistical Sciences, Subject Group Statistics.

FRIDAY, 25 AUGUST 2023			
18:00 – 20:30	**Dinner — Boma braai**		

SATURDAY, 26 AUGUST 2023			
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09:30 – 09:45	**Welcome and opening: James Allison**		
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10:45 – 11:15	Yi Yu	University of Warwick	Robust mean change point testing in high-dimensional data with heavy tails
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	Session II Chair: Jaco Visagie		
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12:15 – 12:45	Noël Veraverbeke	University of Hasselt & North-West University	Bivariate censoring models with covariates
12:45 – 13:15	Ayanendranath Basu	Indian Statistical Institute	Robust hypothesis testing and model selection for the parametric proportional hazard regression models
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	Session III Chair: M.Dolores Jiménez-Gamero		
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15:00 – 15:30	Estate Khmaladze	Victoria University of Wellington	On theory of distribution-free testing
15:30 – 16:00	Yvik Swan	Université Libre de Bruxelles	Independent additive weighted bias distributions and associated goodness-of-fit tests
16:00 – 16:30	**Tea**		
	Session IV Chair: Bruno Ebner		
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17:00 – 17:30	Eduardo García-Portugués	Universidad Carlos III de Madrid	On new omnibus tests of uniformity on the hypersphere with data-driven parameters
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10:30 – 11:00	Valentina Corradi	University of Surrey	Predictive ability tests with possibly overlapping models
11:00 – 11:30	Jeffrey Racine	McMaster University	Locally adaptive online functional data analysis
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10:00 – 10:30	Lajos Horváth	University of Utah	Sequential monitoring for changes in M-estimators of risk models
10:30 – 11:00	Joseph Ngatchou-Wandji	Université de Rennes, EHESP & Université de Lorraine, IECL	Goodness-of-fit tests for discrete response models with covariates
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Abstracts

Robust Hypothesis Testing and Model Selection for the Parametric Proportional Hazard Regression Models

Saturday, 26 Aug, 12:45

Ayanendranath Basu[1], Abhik Ghosh[1], Amarnath Nandy[1], Leandro Pardo[2]

[1]Indian Statistical Institute, [2]Complutense University of Madrid, Spain

The semi-parametric Cox proportional hazards regression model is a widely used tool in applied sciences. A fully parametric proportional hazards scheme, if appropriately modeled, can lead to more efficient inference. As in other parametric schemes, the maximum likelihood estimator is highly nonrobust in the presence of outliers in the data under such a fully parametric proportional hazard model. An alternative robust estimation procedure has recently been proposed extending the concept of the minimum density power divergence estimator (MDPDE) under this set-up. In this lecture, we consider the problem of statistical inference under the parametric proportional hazards model and develop robust Wald-type tests of hypothesis and model selection procedures. We study the robustness properties theoretically and numerically. The practical usefulness of the procedures are illustrated through real life data sets. The important issue of the selection of appropriate robustness tuning parameter is also discussed.

Keywords: *Cox Regression; Minimum Density Power Divergence Estimator; Parametric Survival Model; Robust Wald-type Test; Divergence Information Criterion.*

The econometrics of financial duration modeling

Monday, 28 Aug, 12:00

Giuseppe Cavaliere[1], Thomas Mikosch[2], Frederik Vilandt[2], Anders Rahbek[2]
[1]University of Bologna and University of Exeter, [2]University of Copenhagen

We establish new results for estimation and inference in financial durations models, where events are observed over a given time span, such as a trading day, or a week. For the classical autoregressive conditional duration (ACD) models by Engle and Russell (1998, Econometrica 66, 1127-1162), we show that the large sample behavior of likelihood estimators is highly sensitive to the tail behavior of the financial durations. In particular, even under stationarity, asymptotic normality breaks down for tail indices smaller than one or, equivalently, when the clustering behaviour of the observed events is such that the unconditional distribution of the durations has no finite mean. Instead, we find that estimators are mixed Gaussian and have non-standard rates of convergence. The results are based on exploiting the crucial fact that for duration data the number of observations within any given time span is random. Our results apply to general econometric models where the number of observed events is random.

Keywords: *Likelihood; Tail index; Financial durations; Stationarity.*

Predictive Ability Tests with Possibly Overlapping Models

Sunday, 27 Aug, 10:30

Valentina Corradi[1], Jack Fosten[2], Daniel Gutknecht[2]

[1]University of Surrey, [2]Kings College London, [3]Goethe University

This paper provides novel tests for comparing out-of-sample predictive ability of two or more competing models that are possibly overlapping. The tests do not require pre-testing, they allow for dynamic misspecification and are valid under different estimation schemes and loss functions. In pairwise model comparisons, the test is constructed by adding a random perturbation to both the numerator and denominator of a standard Diebold-Mariano test statistic. This prevents degeneracy in the presence of overlapping models but becomes asymptotically negligible otherwise. The test has correct size uniformly over all null data generating processes. A similar idea is used to develop a superior predictive ability test for the comparison of multiple models against a benchmark. Monte Carlo simulations demonstrate that our tests exhibit very good size control in finite samples reducing both incidences of under- and over-sizing relative to its competitors. Finally, an application to forecasting U.S. excess bond returns provides evidence in favour of models using macroeconomic factors.

Keywords: *Degeneracy; Uniform inference; Block bootstrap; Out-of-sample evaluation; Excess bond returns.*

Another Look at Assessing Goodness-of-fit of Time Series Using Fitted Residuals

Sunday, 27 Aug, 15:00

Richard A. Davis, Leon Fernandes
Columbia University

A fundamental and often final step in time series modeling is to assess the quality of fit of a proposed model to the data. Since the underlying distribution of the innovations that generate a model is typically not prescribed, goodness-of-fit tests typically take the form of testing the fitted residuals for serial independence. However, these fitted residuals are inherently dependent since they are based on parameter estimates. Thus standard tests of serial independence, such as those based on the autocorrelation function (ACF) or distance correlation function (DCF) of the fitted residuals need to be adjusted. The sample splitting procedure in Pfister et al. (2018) is one such fix for the case of models for independent data, but fails to work in the dependent case.

In this paper sample splitting is leveraged in the time series setting to perform tests of serial dependence of fitted residuals using the ACF and DCF. Here the first a_n of the data points are used to estimate the parameters of the model and then using these parameter estimates, the last s_n of the data points are used to compute the estimated residuals. Tests for serial independence are then based on these s_n residuals. As long as the overlap between the a_n and s_n data splits is asymptotically $\frac{1}{2}$, the ACF and DCF tests of serial independence tests often have the same limit distributions as though the underlying residuals are indeed iid. This procedure ameliorates the need for adjustment to the construction of confidence bounds for both the ACF and DCF in goodness-of-fit testing.

Keywords: *Goodness of fit; Serial dependence; ACF; Distance correlation function; Data splitting.*

Analysing fragments of functional data

Sunday, 27 Aug, 10:00

Aurore Delaigle
University of Melbourne

Functional data are often observed only partially, in the form of fragments. In that case, the standard approaches for estimating the covariance function do not work because entire parts of the domain are completely unobserved. In previous work, Delaigle and Hall (2013, 2016) suggested ways of estimating the covariance function, based for example on Markov assumptions. In this work we take a completely different approach which does not rely on such assumptions. We show that, using a tensor product approach, it is possible to reconstruct the covariance function using observations located only on the diagonal of its domain.

Keywords: *Functional data; Fragments; Endpoints.*

Chi-square Goodness-of-fit Tests to Check for Conditional Moment Restrictions

Sunday, 27 Aug, 12:30

Miguel A. Delgado, Antonio Raiola
Universidad Carlos III de Madrid

We propose chi-square goodness-of-fit tests to check for regression model specification or general conditional moment restrictions. Our approach involves partitioning the data into cells, possibly sample dependent, and assessing whether the differences between observed and expected averages of the dependent variable in each cell occurred by chance. This methodology draws inspiration from the classical Pearson goodness-of-fit test. In fact, the test statistic measures the discrepancy between restricted and unrestricted regressogram estimates at each data point, appropriately scaled, using fixed binwidths (the cells). Alternatively, it can be interpreted as a J-test for over-identified restrictions, where the number of cells is greater than the number of parameters estimated by GMM. We propose data-dependent partitions designed to ensure a roughly equal number of observations in each cell or to prioritize specific alternatives, whether parametric or nonparametric, using Neyman-Pearson cells. Through Monte Carlo experiments, we provide evidence of the good small sample properties of the test, which often outperforms existing omnibus specification tests.

Keywords: *Goodness-of-fit tests; Regression specification; Distribution-free-tests; Regressogram; Neyman-Pearson cells.*

On testing randomness of binary images with applications

Saturday, 26 Aug, 14:30

Bruno Ebner
Karlsruhe Institute of Technology

We present new methods for testing complete randomness of binary image data. The tests are based on so called Minkowski functionals such as the area, the perimeter or the Euler-Poincaré characteristic. We derive the limit null distribution of the test statistics by means of Stein's method in the Kolmogorov distance using dependency graphs. A Monte Carlo simulation study shows that the tests are able to detect alternatives and we apply it to data related to some irrational numbers and mathematical constants such as π, e, square root of 2, Euler-Mascheroni constant, and the Catalan constant. Applications to testing the assumption of complete randomness in missing data are discussed.

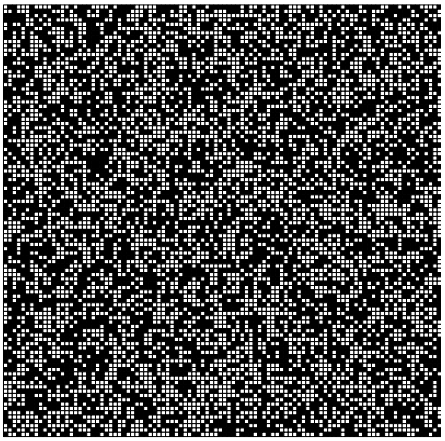

Figure 1: Is this picture completely random?

Keywords: *Binary image analysis; Goodness-of-fit test; Bootstrap method; Stein's method; Dependency graphs.*

Empirical likelihood based testing for multivariate regular variation

Sunday, 27 Aug, 13:00

John Einmahl[1], Andrea Krajina[2]
[1]Tilburg University, [2]University of Göttingen

Multivariate regular variation is a common assumption in the statistics literature and needs to be verified in real-data applications. We develop a novel hypothesis test for multivariate regular variation, employing localized empirical likelihood. We establish the weak convergence of the test statistic to a non-standard, distribution-free limit and hence can provide universal critical values for the test. We show the very good finite-sample behavior of the procedure through simulations and apply the test to several real-data examples.

Keywords: *Asymptotic theory; Distribution-free; Empirical likelihood; Empirical process; Multivariate tail; Regular variation; Tail index.*

A Gaussian Process Approach to Model Checks

Sunday, 27 Aug, 17:30

Juan Carlos Escanciao
Universidad Carlos III de Madrid

This paper proposes a Gaussian Process (GP) approach for testing conditional moment restrictions. Tests are based on squared Neyman-orthogonal function-parametric processes integrated with respect to a GP distribution. The GP approach allows researchers to incorporate prior information on alternatives of interest without given up the omnibus property if the covariance kernel is sufficiently expressive. This methodology combined with a Neyman orthogonalization leads to general, simple and powerful directional-omnibus tests having the following remarkable properties simultaneously: (i) bootstrap-assisted tests are easy to implement in the presence of nuisance parameters (they are simple quadratic forms, and there is no need to re-estimate the nuisance parameters in each bootstrap replication); and (ii) the new tests are valid under general conditions, including higher order conditional moments of unknown form, regularized estimators that are not asymptotically linear (e.g. Lasso) or parameters at the boundary of the parameter space. Novel applications include various models estimated by Lasso and tests for zero conditional treatment effects based on them. The paper introduces a new asymptotic theory and a detail power analysis, which have applications beyond the current setting. Monte Carlo experiments illustrate the sensitivity to the dimension of covariates and the role of the spectrum of the covariance kernel. Finally, an empirical application to the Oregon Health Experiment investigates the impact of health care eligibility on different health outcomes of interest.

Keywords: *Conditional moment restrictions; Orthogonal moments; Omnibus tests; Gaussian Processes; Kernel Machines.*

Detection of breaks in weak location time series models with quasi-Fisher scores

Sunday, 27 Aug, 15:30

Christian Francq[1], Lorenzo Trapani[2], Jean-Michel Zakoian[1]
[1]CREST and University of Lille, [2]University of Leicester

Based on Godambe's theory of estimating functions, we propose a class of cumulative sum, CUSUM, statistics to detect breaks in the dynamics of time series under weak assumptions. First, we assume a parametric form for the conditional mean, but make no specific assumption about the data generating process (DGP) or even about the other conditional moments. The CUSUM statistics we consider depend on a sequence of weights that affect their asymptotic accuracy. Based on Godambe's theory of estimating functions, we propose a class of cumulative sum, CUSUM, statistics to detect breaks in the dynamics of time series under weak assumptions. First, we assume a parametric form for the conditional mean, but make no specific assumption about the data-generating process (DGP) or even about the other conditional moments. The CUSUM statistics we consider depend on a sequence of weights that influence their asymptotic accuracy. Data-driven procedures are proposed for the optimal choice of the sequence of weights, in the sense of Godambe. We also propose modified versions of the tests that allow to detect breaks in the dynamics even when the conditional mean is misspecified. Our results are illustrated using Monte Carlo experiments and real financial data.

Keywords: *Change-points; CUSUM; Estimating functions; Quasi-likelihood estimator (QLE).*

On new omnibus tests of uniformity on the hypersphere with data-driven parameters

Saturday-day, 26 Aug, 17:00

Eduardo García-Portugués, Alberto Fernández-de-Marcos
Universidad Carlos III de Madrid

Two new omnibus tests of uniformity for data on the hypersphere are proposed. The new test statistics exploit closed-form expressions for orthogonal polynomials, feature tuning parameters, and are related to a smooth maximum function and the Poisson kernel. We obtain exact moments of the test statistics under uniformity and rotationally symmetric alternatives, and give their null asymptotic distributions. We consider approximate oracle tuning parameters that maximize the power of the tests against known generic alternatives and provide tests that estimate oracle parameters through cross-validated procedures while maintaining the significance level. Numerical experiments explore the effectiveness of null asymptotic distributions and the accuracy of inexpensive approximations of exact null distributions. A simulation study compares the powers of the new tests with other tests of the Sobolev class, showing the benefits of the former. The proposed tests are applied to the study of the (seemingly uniform) nursing times of wild polar bears.

Keywords: *Directional statistics; Poisson kernel; Sobolev tests; Smooth maximum.*

Spatial structure comparison of point processes on linear networks with applications

Saturday, 26 Aug, 16:30

Wenceslao Gonzalez-Manteiga[1], María Isabel Borrajo[1], Ignacio Gonzalez-Perez[2]
[1]Universidade de Santiago de Compostela, [2]ETH Zurich

Data sets representing the spatial location of a series of observations appear in a wide variety of scenarios, for example, trees in a forest, earthquakes in a region or traffic accidents in road networks. The latter is an example of point patterns which do not lay on a two-dimensional subregion of the plane, but which are constricted to a one-dimensional subset. These types of patterns are said to lay on a linear network. Analysing point processes on linear networks presents greater complexities than working on any Euclidean space, mainly because of the associated metric space.

A vastly studied problem in Statistics is population comparison, i.e., determine whether two (or more) samples are generated by the same stochastic process. This problem also arises when dealing with point processes, for example, the distribution of two species of flora in a forest, outbreaks of natural or caused forest fires, car-car and car-motorcycle collisions on a road network...

In the spatial point processes domain, this comparison problem has already been addressed, however this is not the case for point processes on other different domains. Inferential methods, as the ones proposed for the Euclidean plane, have not yet been developed regarding point processes on linear networks. In this work we study the two-sample problem for point processes on linear networks, proposing two specific testing methods, based on a Kolmogorov-Smirnov and a Cramér-von Mises type statistics. A thorough simulation study is accomplished to detail the finite sample performance of our proposals. The test statistics are also applied to traffic collisions in Rio de Janeiro (Brazil).

Keywords: *Point processes; Linear network; Two-sample problem.*

Sequential Monitoring for Changes in M-estimators of Risk Models

Monday, 28 Aug, 10:00

Lajos Horváth[1], Emese Lazar[2], Zhenya Liu[3], Shixuan Wang[4], Xiaohan Xue[5]

[1]University of Utah, [2]ICMA Centre, Henley Business School, University of Reading, [3]School of Finance, Renmin University of China, [4]Department of Economics, University of Reading, [5]Finance Group, Norwich Business School, University of East Anglia

We propose a sequential monitoring scheme for changes in semiparametric risk models that capture Value-at-Risk (VaR) and Expected Shortfall (ES) jointly. Suppose that we observe a series of asset returns in a historical training sample $\{y_t\}_{t=1}^{M}$. Let v_t^α and e_t^α denote the VaR and ES at a probability level α. The conditional VaR and ES of y for $\alpha \in (0,1)$ are given by

$$v_t^\alpha \equiv G^{-1}(\alpha|\mathcal{F}_{t-1}) = \inf\{y_t \in \mathbb{R}|G(y_t|\mathcal{F}_{t-1}) \geq \alpha\},$$

and

$$e_t^\alpha \equiv E[y_t|y_t \leq v_t^\alpha, \mathcal{F}_{t-1}],$$

respectively, where $G(\cdot|\mathcal{F}_{t-1})$ is the cumulative distribution function of observations y_t given the information set $\mathcal{F}_{t-1}$. The model for asset returns is given by

$$y_t = \sigma_t \epsilon_t, \quad \epsilon_t \sim F(0,1), \qquad \sigma_t^2 = \omega + \beta_1 \sigma_{t-1}^2 + \beta_2 y_{t-1}^2.$$

The variable σ_t^2 is the conditional variance and is assumed to follow a GARCH(1,1) process. The distribution function of ϵ_0 is denoted by F. We define

$$V(x) = \int_{-\infty}^{x} s dF(s).$$

The GARCH–FZ model has

$$\begin{aligned} v_t &= a\sigma_t, \quad \text{where } a = F^{-1}(\alpha) \\ e_t &= b\sigma_t, \quad \text{where } b = \frac{1}{\alpha} V\left(F^{-1}(\alpha)\right) = \frac{1}{\alpha} V(\alpha). \end{aligned}$$

$\theta = (a, b, \omega, \beta_1, \beta_2)^\top$ is the set of parameters in this model, which is estimated by minimizing the FZ0 loss function shown in Patton, Ziegel, and Chen, Dynamic semiparametric models for expected shortfall (and value-at-risk). Journal of Econometrics 211(2019), 388–413. We assume that there is now change in the parameters of $y_t, 1 \leq t \leq M$, which is used as the training sample. We wish to test sequentially, if the risk parameters change after the training sample. The FZ loss function is

$$\bar{\ell}_t(\mathbf{u}) = -\frac{1}{\alpha \bar{e}_t(\mathbf{u})} R\left(\frac{\bar{v}_t(\mathbf{u}) - y_t}{h}\right)(\bar{v}_t - y_t) + \frac{\bar{v}_t(\mathbf{u})}{\bar{e}_t(\mathbf{u})} + \log\left(-\bar{e}_t(\mathbf{u})\right),$$

where $\mathbf{u} = (u_1, u_2, \ldots, u_5)^\top$ with

$$\bar{v}_t(\mathbf{u}) = u_1 \bar{\sigma}_t(\bar{\mathbf{u}}), \qquad \text{and} \qquad \bar{e}_t(\mathbf{u}) = u_2 \bar{\sigma}_t(\bar{\mathbf{u}}).$$

We denote $\bar{\mathbf{u}} = (u_3, u_4, u_5)^\top$ and $\bar{\sigma}_t(\bar{\mathbf{u}})$ is defined by the recursion

$$\bar{\sigma}_t^2(\bar{\mathbf{u}}) = u_3 + u_4\bar{\sigma}_{t-1}^2(\bar{\mathbf{u}}) + u_5 y_{t-1}^2, \quad 2 \le t \le M,$$

starting with some initial value $\bar{\sigma}_1^2$. Based on the training sample $\{y_t\}_{t=1}^M$, we estimate the parameter values by minimizing the loss function

$$\bar{\mathcal{L}}_M(\mathbf{u}) = \frac{1}{M}\sum_{t=1}^{M} \bar{\ell}_t(\mathbf{u}), \qquad \mathbf{\Theta} = (\underline{u}_i \le u_i \le \bar{u}_i, i = 1, 2, 3, 4, 5)$$

with $-\infty < \underline{u}_1 < \bar{u}_1 < 0, -\infty < \underline{u}_2 < \bar{u}_2 < 0, 0 < \underline{u}_i < \bar{u}_i < \infty, i = 3, 4, 5$. We compute the loss functions at times $M+1, \ldots$ and define the detector

$$\mathcal{D}_{M,k} = \left\| \mathbf{D}^{-1/2} \sum_{t=M+1}^{M+k} \nabla \bar{\ell}_t \left(\hat{\boldsymbol{\theta}}_M \right) \right\|,$$

where $\|\cdot\|$ denotes a norm in $\mathbb{R}^5$, $\mathbf{D}$ is the asymptotic covariance of the estimators from the training sample. The boundary function is defined as

$$\beth_{M,k} = \dashv M^{1/2} \left(1 + \frac{k}{M}\right) \lfloor \left(\frac{k}{k+M}\right),$$

$\inf_{\varepsilon \le t < \infty} \lfloor(t) > 0$ for all $\varepsilon > 0$ and there is $\mu < 1/2$ such that $0 < \lim_{t\to 0} \lfloor(t)/t^\mu < \infty$. We define the stopping time of detection as

$$\hat{k}_M = \min\{k : \mathcal{D}_{M,k} > \beth_{M,k}\}$$

with $\hat{k}_M = \infty$ if $\mathcal{D}_{M,k} \le \beth_{M,k}$ for all $k \ge 1$. The parameter $\dashv$ is used to control the probability of false rejection.

Theorem *If H_0 and some regularity assumptions hold, then*

$$\lim_{M\to\infty} P\left\{\hat{k}_M < \infty\right\} = P\left\{\sup_{0<t<1} \frac{1}{\lfloor(t)} \|\mathbf{W}(t)\| < \dashv\right\},$$

where $\mathbf{W}(t) = (W_1(t), \ldots, W_5(t))^\top$, with $W_1(t), W_2(t), \ldots, W_5(t)$ independent Wiener processes.

Monte Carlo simulations show that the proposed test has good size control under the null hypothesis and high power under alternative hypotheses of various change point scenarios in finite samples. Empirical applications based on the S&P 500 index and the GBP/EUR exchange rate illustrate that our proposed test is able to detect change points in real–time.

Keywords: *Value at risk; Expected shortfall; Change point; FZ loss function; Weak approximations sequential testing.*

Testing homoscedasticity of a large number of populations

Sunday, 27 Aug, 16:30

M. Dolores Jiménez-Gamero[1], Marina Valdora[2], Daniela Rodríguez[2]

[1]Universidad de Sevilla, [2]Universidad de Buenos Aires

Given k populations and assuming that independent samples are available from each of them, this talk deals with the problem of testing for the equality of the k population variances. In contrast to the classical setting, where k is kept fixed and the sample size from each population increases without bound, here k is assumed to be large and the size of each sample is small in comparison to k. A new test is proposed. The asymptotic distribution of the test statistic is stated under the null hypothesis of equality of the k variances as well as under alternatives, which allows us to study the consistency of the test. Specifically, it is shown that the test statistic is asymptotically free distributed under the null hypothesis. The finite sample performance of the test based on the asymptotic null distribution is studied via simulation. Two bootstrap approximations to the null distribution of the test statistic are also investigated.

Keywords: *Testing; Homoscedasticity; Consistency.*

On theory of distribution-free testing

Saturday, 26 Aug, 15:00

Estate Khmaladze
Victoria University of Wellington

I will present a new approach to distribution-free testing on statistical hypothesis. Then I will try to show that the approach is broadly applicable: from distribution-free testing for discrete distributions, to distribution free testing for Markov chains and diffusion processes. Much later I realised that the roots of the approach can be traced to K. Pearson's, although on the surface what comes out is a competition to great χ^2 test.

Keywords: *Unitary operators; Function-parametric processes; Distribution-free tests.*

Bayesian nonparametric analysis of the time-varying spectral density of locally stationary time series

Sunday, 27 Aug, 14:30

Claudia Kirch[1], Yifu Tang[2], Kate Lee[2], Renate Meyer[2]

[1]Otto-von-Guericke University Magdeburg, [2]University of Auckland

Many real-world phenomena can well be modelled by locally stationary time series with a slowly changing dependency structure. For such time series the estimation of the time-varying spectral density is of particular interest. In this talk we propose a Bayesian nonparametric method for this purpose based on a suitable dynamic Whittle likelihood for locally stationary time series in combination with a Bernstein-Dirichlet process prior. We prove posterior consistency and obtain corresponding contraction rates. Furthermore, an empirical study suggests that the methodology works well in practice.

Keywords: *Time-varying spectral density; Bayesian nonparametric; Local stationarity.*

Monitoring a developing pandemic with available data

Monday-day, 28 Aug, 09:30

Maria Dolores Martinez-Miranda[1], M. Luz Gámiz[1], Enno Mammen[2], Jens Perch Nielsen[3]

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In this talk we present a full dynamic system to monitoring and understanding the most important transitions in a developing pandemic: infection to infection, infection to hospitalization and hospitalization to death or recovery. While the latter transition is well defined and a follow-up-type survival analysis is possible, with the transitions infection-infection and infection-hospitalization, the number of individuals involved are biased by dynamic definitions and underestimation leading to low quality exposure. Using data from the recent Covid-19 pandemic, and two different mathematical approaches to describe the two types of transitions, we are able to describe and forecast the spread and the severity of the pandemic, including relevant indicators such as the median time from admission in hospital to recovery or death depending on the admission date, or the probability that a patient who has been in hospital for a number of days can leave it alive.

One important feature of our modelling technique when applied to a developing pandemic is that it only relies on simple and publicly available data. This appealing feature implies that we have to deal with a missing link data problem in survival analysis where the individual follow-up is not registered. This missing data problem has been addressed in our paper Gámiz et al. (2022) using nonparametric iterative techniques, but in a simpler model.

Another important feature of our proposal is the dynamic modelling that allows not only the dynamic estimation, but the variation over time of the very definition of the underlying problem. Accounting for this requires developing a new statistical methodology for the analysis of longitudinal data where exposure is only vaguely understood, partly because the very definition of exposure might change over time. Such methodology has been introduced in our recent paper Gámiz et al. (2023) using Hawkes processes and nonparametric methods.

References:

Gámiz, M. L., Mammen, E., Martínez-Miranda, M. D. and Nielsen, J. P. (2023). Monitoring and forecasting events based on low quality exposure information. Submitted.

Gámiz, M. L., Mammen, E., Martínez-Miranda, M. D. and Nielsen, J. P. (2022). Missing link survival analysis with applications to available pandemic data. Computational Statistics & Data Analysis, 169, 107405.

Keywords: *Survival; Dynamic; Counting process; Hawkes process; Pandemic; Low-quality exposure.*

Omnibus Diagnostic Procedures for Vector Multiplicative Errors Models

Monday, 28 Aug, 12:30

Simos Meintanis[1], Šárka Hudecová [2], Joseph Ngatchou-Wandji[3]

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We suggest specification tests for the conditional mean function in vector multiplicative error models. The test statistics are easy to compute given a suitable estimator of the model parameters. Consistency of the test statistic is proved, the asymptotic distribution of the test under the null hypothesis is studied, while a bootstrap resampling is used in order to approximate critical points and actually carry out the test. Finite–sample results are presented as well as applications of the proposed procedures to real data from the financial markets.

Keywords: *Multivariate time series; Goodness-of-fit test; Bierens' test; Bootstrap test.*

Change point analysis – the empirical Hankel transform approach

Saturday, 26 Aug, 10:15

Bojana Milošević, Žikica Lukić
University of Belgrade – Faculty of Mathematics

In this study, we introduce novel tests for detecting change-points in the distribution of a sequence of independent observations of various types, including matrix-valued random variables. We present the limiting properties of these tests and demonstrate their quality through an extensive simulation study. To illustrate their application, we employ these tests for change-point detection in cryptomarkets.

Keywords: *Hankel transform; Two-sample tests; Matrix distributions; Stability of cryptomarkets.*

Goodness-of-fit tests for discrete response models with covariates

Monday, 28 Aug, 10:30

Joseph Ngatchou-Wandji[1], Simos Meintanis[2,3], Leonard Santana[3], Marius Smuts[3]

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We propose goodness-of-fit tests for models of count responses with covariates. Our main focus is on the null hypothesis that the observed data come from a Poisson, a negative binomial, or a binomial regression model, but the method is fairly general allowing for the responses to follow, conditionally on covariates, any given discrete distribution. The test criteria are formulated by using the probability generating function and they are convenient from the computational point of view. Asymptotic as well as Monte Carlo results are presented. Applications on real data are also reported.

Keywords: *Poisson regression; Binomial regression; Negative binomial regression; Goodness-of-fit test; Probability generating function; Bootstrap test.*

Robust testing to compare regression curves

Sunday, 27 Aug, 17:00

Juan Carlos Pardo-Fernandez[1], Graciela Boente[2]

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This paper focuses on the problem of testing the null hypothesis that the regression functions of several populations are equal under a general nonparametric regression model. It is well known that linear kernel regression estimators are sensitive to atypical responses. These distorted estimates will influence the test statistic constructed from them so the conclusions obtained when testing equality of several regression functions may also be affected. In recent years, the use of testing procedures based on empirical characteristic functions has shown good practical properties. For that reason, to provide more reliable inferences, we construct a test statistic that combines characteristic functions and residuals obtained from a robust smoother under the null hypothesis. The asymptotic distribution of the test statistic is studied under the null hypothesis and under root$-n$ contiguous alternatives. A Monte Carlo study is performed to compare the finite sample behaviour of the proposed test with the classical one obtained using local averages. The reported numerical experiments show the advantage of the proposed methodology over the one based on Nadaraya–Watson estimators for finite samples.

Keywords: *Characteristic function; Hypothesis testing; Nonparametric regression models; Robust estimation; Smoothing techniques.*

Lack-of-fitness model checks

Valentin Patilea and François Portier
CREST-Ensai, France

Olkin and Spiegelman (1987) introduced a semiparametric estimator of the density defined as a mixture between the maximum likelihood estimator and the kernel density estimator. Mazo and Portier (2021) pointed out that the mixture weight associated with the parametric density provides a measure for the goodness-of-fit of the parametric density model. They call this mixture weight the fitness coefficient, and estimate it by maximum likelihood. Under mild conditions on the, possibly multivariate, density model, Mazo and Portier show that the fitness coefficient converges in probability to 1 if the parametric density model is correct, and zero otherwise. We investigate the convergence in distribution of the lack-of-fitness statistic, defined as the suitably normalized difference between 1 and the fitness coefficient. When the parametric density model is correct, the lack-of-fitness statistic converges in distribution to the positive part of a standard Gaussian variable, regardless the fixed dimension of the i.i.d. observations. The behavior of the statistic when the model is misspecified is non-standard. The behavior of the lack-of-fitness statistic suggests few goodness-of-fit approaches that we investigate. The extension of the lack-of-fitness statistic to more complex models is also discussed.

Keywords: *Concavity; Goodness-of-fit; Leave-one-out density estimator; Likelihood-ratio tests.*

Locally Adaptive Online Functional Data Analysis

Sunday, 27 Aug, 11:00

Jeffrey Racine[1], Valentin Patilea[2]

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One drawback with classical smoothing methods (kernels, splines, wavelets etc.) is their reliance on assuming the degree of smoothness (and thereby assuming continuous differentiability up to some order) for the underlying object being estimated. However, the underlying object may in fact be irregular (i.e., non-smooth and even perhaps nowhere differentiable) and, as well, the (ir)regularity of the underlying function may vary across its support. Elaborate adaptive methods for curve estimation have been proposed, however, their intrinsic complexity presents a formidable and perhaps even insurmountable barrier to their widespread adoption by practitioners. We contribute to the functional data literature by providing a pointwise MSE-optimal, data-driven, iterative plug-in estimator of "local regularity" and a computationally attractive, recursive, online updating method. In so doing we are able to separate measurement error "noise" from "irregularity" thanks to "replication", a hallmark of functional data. Our results open the door for the construction of minimax optimal rates, "honest" confidence intervals, and the like, for various quantities of interest.

Keywords: *Nonparametric, Unknown Smoothness, Local Holder Exponent Estimation.*

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ocd: High-dimensional, multiscale online changepoint detection and inference

Saturday, 26 Aug, 09:45

Richard J. Samworth[1], Yudong Chen[2] , Tengyao Wang[2]

[1]University of Cambridge, [2]London School of Economics and Political Science

We introduce a new method for high-dimensional, online changepoint detection in settings where a p-variate Gaussian data stream may undergo a change in mean. The procedure works by performing likelihood ratio tests against simple alternatives of different scales in each coordinate, and then aggregating test statistics across scales and coordinates. The algorithm is online in the sense that both its storage requirements and worst-case computational complexity per new observation are independent of the number of previous observations; in practice, it may even be significantly faster than this. We prove that the patience, or average run length under the null, of our procedure is at least at the desired nominal level, and provide guarantees on its response delay under the alternative that depend on the sparsity of the vector of mean change. We further discuss the problems of constructing a confidence interval for the changepoint location, and estimating the support of the vector of mean change. Numerical results on simulated and real data confirm the practical effectiveness of our proposals, which are implemented in the R package ocd.

Keywords: *Changepoint detection; Online inference; Multiscale methods; Confidence interval.*

Inference for extremal regression with dependent heavy-tailed data

Monday, 28 Aug, 11:30

Gilles Stupfler[1], Abdelaati Daouia[2], Antoine Usseglio-Carleve[3]
[1]University of Angers, [2]Toulouse School of Economics, [3]Avignon Université

Nonparametric inference on tail conditional quantiles and their least squares analogs, expectiles, remains limited to i.i.d. data. We develop a fully operational inferential theory for extreme conditional quantiles and expectiles in the challenging framework of $\alpha-$mixing, conditional heavy-tailed data whose tail index may vary with covariate values. This requires a dedicated treatment to deal with data sparsity in the far tail of the response, in addition to handling difficulties inherent to mixing, smoothing, and sparsity associated to covariate localization. We prove the pointwise asymptotic normality of our estimators and obtain optimal rates of convergence reminiscent of those found in the i.i.d. regression setting, but which had not been established in the conditional extreme value literature. Our assumptions hold in a wide range of models. We propose full bias and variance reduction procedures, and simple but effective data-based rules for selecting tuning hyperparameters. Our inference strategy is shown to perform well in finite samples and is showcased in applications to stock returns and tornado loss data.

Keywords: *Conditional quantiles; Conditional expectiles; Extreme value analysis; Heavy tails; Inference; Mixing; Nonparametric regression.*

Independent additive weighted bias distributions and associated goodness-of-fit tests

Saturday, 26 Aug, 15:30

Yvik Swan[1], Bruno Ebner[2]

[1]Université Libre de Bruxelles, [2]Karlsruhe Institute of Technology

We use a Stein identity to define a new class of parametric distributions which we call "independent additive weighted bias distributions." We investigate related L^2-type discrepancy measures, empirical versions of which not only encompass traditional ODE-based procedures but also offer novel methods for conducting goodness-of-fit tests in composite hypothesis testing problems. We determine critical values for these new procedures using a parametric bootstrap approach and evaluate their power through Monte Carlo simulations. As an illustration, we apply these procedures to examine the compatibility of two real data sets with a compound Poisson Gamma distribution.

Keywords: *Stein identity; Independent additive bias; Goodness-of-fit; Composite hypothesis testing; Compound Poisson.*

Testing for sufficient follow-up in censored survival data by using extremes

Saturday, 26 Aug, 11:45

Ingrid Van Keilegom[1], Ping Xie[1], Mikael Escobar-Bach[2]
[1]KU Leuven, [2]University of Angers

In survival analysis, one often encounters that some individuals, referred to as cured individuals, never experience the event of interest. When analyzing time-to-event data with a cure fraction, it is crucial to check the assumption of 'sufficient follow-up', which means that the right extreme of the censoring time distribution is larger than that of the survival time distribution for the non-cured individuals. However, the available methods to test this assumption are limited in the literature. In this article, we study the problem of testing whether follow-up is sufficient for light-tailed distributions and develop a simple novel test. The proposed test statistic compares an estimator of the non-cure proportion under sufficient follow-up to one without the assumption of sufficient follow-up. A bootstrap procedure is employed to approximate the critical values of the test. We also carry out extensive simulations to evaluate the finite sample performance of the test and illustrate the practical use with applications to leukemia and breast cancer datasets.

Keywords: *Bootstrap; Cure models; Extreme value theory; Hypothesis test; Kaplan-Meier estimator; Survival analysis.*

Bivariate censoring models with covariates

Saturday, 26 Aug, 12:15

Noël Veraverbeke

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In this talk we consider a pair (T_1, T_2) of survival times, subject to right random censoring and in the presence of a covariate random variable X. We assume that (T_1, T_2) and the censoring time(s) are conditionally independent, given X. The goal is nonparametric estimation of the joint conditional survival function $S_x(t_1, t_2) = P(T_1 > t_1, T_2 > t_2 \mid X = x)$. 0ur starting point is the inverse probability weighting idea. This is of course a challenging problem due to the presence of the unknown joint conditional censoring distribution. We there for restrict to two important specific censoring schemes: univariate censoring (only one censoring variable for (T_1, T_2)) and one-component censoring (T_1 fully observed and T_2 subject to censoring). Our estimators involve Nadaraya-Watson weights that smooth over the values of the covariate X. We prove asymptotic normality of the joint conditional survival function estimators in the above cases.

Keywords: *Bivariate survival; Censoring; Covariates; Nonparametric estimation.*

Robust mean change point testing in high-dimensional data with heavy tails

Saturday, 26 Aug, 10:45

Yi Yu[1], Mengchu Li[1], Yudong Chen[2], Tengyao Wang[2]

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We study a mean change point testing problem for high-dimensional data, with exponentially- or polynomially-decaying tails. In each case, depending on the ℓ_0-norm of the mean change vector, we separately consider dense and sparse regimes. We characterise the boundary between the dense and sparse regimes under the above two tail conditions for the first time in the change point literature and propose novel testing procedures that attain optimal rates in each of the four regimes up to a poly-iterated logarithmic factor. By comparing with previous results under Gaussian assumptions, our results quantify the costs of heavy-tailedness on the fundamental difficulty of change point testing problems for high-dimensional data.

To be specific, when the error vectors follow sub-Weibull distributions, a CUSUM-type statistic is shown to achieve a minimax testing rate up to $\sqrt{\log\log(8n)}$. When the error distributions have polynomially-decaying tails, admitting bounded α-th moments for some $\alpha \geq 4$, we introduce a median-of-means-type test statistic that achieves a near-optimal testing rate in both dense and sparse regimes. In particular, in the sparse regime, we further propose a computationally-efficient test to achieve the exact optimality. Surprisingly, our investigation in the even more challenging case of $2 \leq \alpha < 4$, unveils a new phenomenon that the minimax testing rate has no sparse regime, i.e. testing sparse changes is information-theoretically as hard as testing dense changes. This phenomenon implies a phase transition of the minimax testing rates at $\alpha = 4$.

Keywords: *High-dimensional mean change point; Testing; Heavy-tailedness*

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