Proceedings

Titles and Abstracts of the 3rd LmB Conference on Multivariate Statistical Models: Count and Semi-Continuous

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Abstract: For this 3rd LmB conference at Besançon from 06 to 08 July 2022, there are twenty two Titles and Abstracts provided by their authors that we sincerely thank.

Keywords: Associated kernel estimator; Exponential family; Generalized linear model; Integer-valued time series; Population size.

MSC: 62F10; 62F15; 62G01; 62G05; 62G07; 62H05; 62H10; 62J12; 62M10.

On general exponential weight functions, variation phenomenon and extensions

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Weighted distributions are used for both count data and positive continuous data. In this work, general weighted exponential distributions including modified exponential ones are widely used with great ability in statistical applications as reliability. In univariate case, we investigate full exponential weight functions and their extensions from any nonnegative continuous reference weighted distribution. Several properties and their connections with the recent variation phenomenon are then established. In particular, characterizations, weightening operations and dual distributions are set forward. Illustrative examples are extensively discussed. As a perspective, we can extend to the multivariate case. Other extensions are also discussed to conclude This is a joint work with Aboubacar Y. Touré and Célestin C. Kokonendji; see [1].

Bias correction in multivariate associated kernel estimators for probability mass functions

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Two multiplicative bias correction (MBC) approaches for nonparametric multivariate associated kernel estimators for joint probability mass functions in the context of discrete supported data are proposed. Both techniques reach an optimal rate of convergence of the mean integrated squared error. We show some properties of the MBC multivariate associated kernel estimators like bias, variance and mean integrated square error. A simulation study and an application on a real count data set illustrate the performance of the MBC estimators based on the Dirac Discrete Uniform associated kernel in terms of the integrated squared error and integrated squared bias. This is a joint work with Lynda Harfouche, Nabil Zougab and Benedikt Funke; see [2].

Bayesian functional linear regression estimation with extension to scalar and categorical covariates

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We consider a linear regression model with a scalar response variable and categorical, scalar and functional covariates, that act additively in the model. Our objective is to estimate the parameters of this model, while maintaining an interpretability for the part of the model including the functional covariates. This work is an extension of the Bliss model [3] developed in a Bayesian framework with only functional covariates. We propose to extend the Bliss method to a more general model that also contains categorical and scalar covariates. In the following, we explain the extended model and how to estimate the parameters in an interpretable way. An illustration is made on simulated data and a real data set obtained in the filed of vine dieback. This is a joint work with Meili Baragatti, Nadine Hilgert, Nathalie Smits and Paul-Marie Grollemund.

Reparameterized count and semi-continuous regression models

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Regression models are typically constructed to model the mean and dispersion/precision of a distribution. However, the density or probability mass function of several distributions is not indexed by the mean and dispersion/precision parameters. In this context, this work provides a collection of regression models considering new parameterizations in terms of the mean and dispersion/precision parameters. The main advantage of our new parametrizations is the straightforward interpretation of the regression coefficients in terms of the expectation and dispersion, as usual in the context of generalized linear models. The maximum likelihood method is used to estimate the model parameters.

Linking INAR, INGARCH and compartmental epidemiological models

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In this talk I will discuss some links between the well-known INAR and INGARCH frameworks for count time series on the one hand and compartmental epidemiological models on the other. The starting point is an alternative thinning-based representation of the Poisson INGARCH(1, 1) model. It has an appealing mechanistic interpretation as a stochastic epidemic process, similar to the SEIR (susceptible-exposed- infected-recovered) model. Moreover, a slight modification of the model formulation results in a generalization of the INAR(1) to a new INARMA(1, 1) model. I will discuss the derivation of some stochastic properties of these models, generalizations to the compound-Poisson case as well as remaining differences to compartmental epidemiological models. This will be completed by an application of various models to a data set from routine surveillance of infectious diseases in Germany.

Bivariate count distributions with specified conditionals distributions

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Bivariate distribution whose conditionals are both either Poisson or geometric or binomial distributions are studied. Useful structural properties of these distribution namely marginal distributions, moments, generating functions, stochastic ordering etc. are investigated. Negative correlation, marginal over-dispersion, distribution of sum, and distribution of the conditional given the sum are also derived. The distributions are shown to be a member of the exponential family and some natural but useful consequences are also outlined.. Simulation studies are reported to explore the flexibility of the distributions with various choices of the model parameters. Finally, these bivariate distributions are fitted to some bivariate count data with inherent negative correlation to illustrate their suitability.

Censored Poisson regression with missing censoring indicators

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Poisson regression has become a classical and widely used tool to investigate the relationship between a set of covariates (or explanatory variables) and a count response. We consider the situation where the count of interest is randomly right-censored (for example, in a study of health-care utilization, patients reporting their number of visits to a doctor as "8 visits or more" provide a censored count, that is, a lower bound on the true unobserved count). The literature on censored count data analysis already contains several approaches for handling such data. In this work, we additionally suppose that the censoring indicator, which tells whether an observed count is censored or not, is missing at random for some subjects. We propose a multiple-imputation based estimator of the regression parameter of a Poisson regression model in this setting. We establish its consistency and asymptotic normality. Variance estimation in multiple imputation is usually handled using Rubin's rule. Here, we obtain an explicit expression for the asymptotic variance of the proposed estimator. A consistent estimate is proposed for this asymptotic variance. Then, we propose and investigate a doubly robust augmented inverse-probability-weighted (AIPW) estimate. This estimate is robust against misspecification of either the missing mechanism or the model for the missing data. We report the results of a simulation study investigating the finite sample performance of the proposed estimators. We compare our results with the naive complete-case estimator. The discussion discusses alternative estimation methods and research perspectives. This is a joint work with Bilel Bousselmi and Abderrazek Karoui; see [4].

The vanishing learning rate asymptotic for linear L^2-boosting

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We investigate the asymptotic behaviour of gradient boosting algorithms when the learning rate converges to zero and the number of iterations is rescaled accordingly. We mostly consider L^2-boosting for regression with linear base learner as studied in [5] and analyze also a stochastic version of the model where subsampling is used at each step [6]. We prove a deterministic limit in the vanishing learning rate asymptotic and characterize the limit as the unique solution of a linear differential equation in an infinite dimensional function space. This is a joint work with Clément Dombri; see [7].

Estimation in the zero-inflated bivariate Poisson model with an application to health-care utilization data

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Data on the demand for medical care is usually measured by a number of different counts. These count data are most often correlated and subject to high proportions of zeros. However, excess zeros and the dependence between these data can jointly affect several utilization measures. In this paper, the zero-inflated bi- variate Poisson regression model (ZIBP) was used to analyze health-care utilization data. First, the asymptotic properties of the maximum likelihood estimator (MLE) of this model were investigated theoretically. Then, a simulation study is conducted to evaluate the behaviour of the estimator in finite samples. Finally, an application of the ZIBP model to health care demand data is provided as an illustration. This is a joint work with Jean-François Dupuy and Konan Jean Geoffroy Kouakou; see [7].

Generalized variation indexes for multivariate semi-continuous distributions and extensions

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We introduce some new indexes to measure the departure of any multivariate continuous distribution on the non-negative orthant of the corresponding space from a given reference distribution. The reference distribution may be an uncorrelated exponential model. The proposed multivariate variation indexes which are a continuous analogue to the relative Fisher dispersion indexes of multivariate count models are also scalar quantities, defined as ratios of two quadratic forms of the mean vector and the covariance matrix. They can be used to discriminate between continuous positive distributions. Generalized and multiple marginal variation indexes with and without correlation structure, respectively, and their relative extensions are discussed. The asymptotic behaviors and other properties are studied. Illustrative examples as well as numerical applications are analyzed under several scenarios, leading to appropriate choices of multivariate models. Some concluding remarks and possible extensions are made. This is a joint work with Aboubacar Y. Touré and Amadou Sawadogo; see [9].

Duality of exponential families and large deviations

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If μ has Laplace transform

$$\exp(\ell_\mu(s)) = \int_{\mathbb{R}^d} e^{-\langle s,x\rangle}\mu(dx),$$

we say that μ^* is a dual measure of μ if

$$-\ell'_{\mu^*}(-\ell'_\mu(s)) = s.$$

We link this definition with the Large Deviations Theorem and discuss the existence of the dual measure in a variety of cases. Associated to the main theme of the conference, we concentrate on the case of the dilogarithm distribution on non negative integers, which generates the exponential family with variance function $-1 + e^m$ It has many interesting properties, like being self dual like the gamma law. This lecture is based on [10].

A triple Poisson model for estimating animal abundance

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Ecological data on animal abundance is vital when developing conservation and management programmes. Monitoring animal populations, however, is a very challenging task. Depending on the species of interest, it could demand too much time and resource that may not be available. In this talk I present scenarios where data scarcity may arise, and how to estimate population abundance based on different assumptions. I introduce a novel modelling framework utilising a triple Poisson hierarchy, which can be used to estimate animal abundance based on scarce vestige data. This is a joint work with John P. Hinde and Clarice G.B. Demétrio.

Generalized linear models for subordinated Lévy processes and multivariate extension

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Generalized linear models, introduced by Nelder and Wedderburn, allowed to model the regression of normal and nonnormal data. While doing so, the analysis of these models could not be obtained without the explicit form of the variance function. In this talk, we determine the link and variance functions of the natural exponential family (NEF) generated by the class of subordinated Lévy processes. In this framework, we introduce a class of variance functions that depends on the Lambert function. In this regard, we call it the Lambert class, which covers the variance functions of the NEFs generated by the subordinated gamma processes and the subordinated Lévy processes by the Poisson subordinator. Notice that the gamma process subordinated by the Poisson one is excluded from this class. The concept of reciprocity in NEFs was given in order to obtain an exponential family from another one. In this context, we get the reciprocal class of the NEF generated by the class of subordinated Lévy processes.

It is well known that the variance function represents an essential element for the determination of the quasi-likelihood and deviance functions. Then, we use the expression of our variance function in order to maintain them. This leads us to analyze the proposed generalized linear model. We illustrate some of our models with applications to the daily exchange rate returns of the Tunisian Dinar against the U.S. Dollar and the damage incidents of ships. A multivariate extension is in progress with unknown link and variance functions. One can refer to [11].

The spatial integer-valued auto-regressive model based on non-regular lattice

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COVID-19 has swept through the world since December 2019 and caused a large number of infections and deaths due to its high contagious nature. Spatial analysis on the spread of such pandemic is greatly important for disease control and management [12]. In relation to the modelling of such pandemic, this research proposes the class of models that relates a spatial count event at a site j with its neighbouring sites via a thinning-based auto-regressive equation of the form: $Y_j = \alpha \circ \sum_{k \neq j} w_{kj} Y_k + \epsilon_j$ with an adjacency binary matrix W. This family of spatial discrete models is quite flexible as these models can accommodate for spatial events that lie under both the regular and irregular lattices and also generalizes the family of higher-ordered integer-valued auto-regressive models with innovation term ϵ_j. The choice of the innovation distribution depends on the margin of dispersion in the spatial data. The estimation of parameters is handled by the conditional maximum likelihood approach and the corresponding asymptotic properties are established. In the application part, we investigate the spatial patterns of COVID-19 transmission in Netherlands using the proposed model with the Poisson innovations. This is a joint work with Dimitris Karlis, Azmi M. Chutoo .

Asymptotic multivariate correlation estimation between the average effect of a road safety measure and risks of crash data

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This paper deals with the asymptotic estimation of the correlation between different constrained parameters related to the multinomial combination of accident data obtained after the implementation of a road safety measure. The explicit asymptotic correlation is achieved through Schur complements technical method. This method of Schur's complement makes it possible to obtain a formal expression of the correlation between the average effect of the measure and the different types of accident risk. This approach also provides a powerful tool to formally compute the explicit correlation between two different accident risks whatever the experimental sites. The easiness of the obtention of the asymptotic correlations without matrix inversion is an attractive aspect of this new approach. Some examples of formal estimation are discussed to back up the method. This is a joint work with Aboubacari Abdou Amadou.

A non-parametric method of estimation of the population size in capture-recapture experiments

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A method for estimating a lower bound of the population size in capture recapture samples is presented, and its asymptotic properties are provided. The introduced estimator is based on the empirical probability generating function of the observed data, and it is consistent for count distributions having a log-convex probability generating function (LC-class). This is a large family which includes Mixed and Compound-Poisson distributions, other distributions that are not Mixed or Compound-Poisson and their independent sums and finite mixtures as well. Some examples of application are also analysed and discussed. One can refer to [13–15].

New exponential dispersion models for count data

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In this project we are interested in fitting a discrete probability distribution to data that show overdispersion and zero-inflation. In many scientific fields, one deals with random phenomena having these properties, for instance, actuarial science, health economics, and behavioral science. Traditional models of count data are based on the Poisson and the negative binomial distributions, but these do not fit the data properly in case of overdispersion and zero-inflation. Many parameterized models have been developed and described in the literature to provide a better fit, for instance generalized Poisson, generalized negative binomial, Lindley, Poisson-inverse Gaussian, etc.

Our approach is based on the concept of exponential dispersion models (EDM). Our probability distributions belong to a class of exponential families with specific variance functions. We consider two classes with three-parameter variance functions: $V(m) = m(1 + m/p)^r$, and $V(m) = m(1 - m/p)^{-r}$, where $m > 0$ is the mean parameter, $p > 0$ the dispersion parameter, and $r = 0, 1, ...$ the power parameter. The framework of these two classes is flexible, covers traditional models, generalizes to a wide range of probability models, and is well-suited for fitting overdispersed, zero-inflated count data.

In this talk we will discuss some properties of these models, and we will show how to compute numerically the probability mass function associated with the variance functions. Furthermore, we examine the goodness-of-fit of these distributions when applied to a range of data sets, where we compare our models with those from literature, assessing the goodness-of-fit by traditional statistical measures. This is a joint work with Shaul Bar-Lev; see [16,17].

Unsupervised classification method based on nonparametric functional mode estimation

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We are concerned on the problem of unsupervised classification problem in the framework of nonparametric functional data. We first construct a classification method based on a recursive estimation of the mode of the distribution of a functional random variable, this estimator is based on a pseudo-density estimator. We then study the asymptotic properties of these the proposed estimator. We then showed the performance of the proposed unsupervised classification estimator by considering a real electroencephalography dataset. Finally, we compared our estimator to a parametric approach based on a Stochastic block Model for node-weighted networks based on two emission laws.

On Bayesian bandwidths in semiparametric modelling for nonnegative orthant data with diagnostics

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We consider a suitable semiparametric approach for estimating multivariate nonnegative orthant densities, and suitable for real data (continuous, discrete or mixed) vectors bounded to the left by the null vector. We first review the recent relative variability indexes for multivariate nonnegative continuous and count distributions. As a prelude, the classification of two comparable distributions having the same mean vector is done through under-, equi- and over-variability with respect to the reference distribution. Multivariate associated kernel estimators are then reviewed with new proposals that can accommodate any nonnegative orthant dataset. We focus on bandwidth matrix selections by adaptive Bayesian method for semicontinuous supports. Finally, we introduce a flexible semiparametric approach for estimating all these distributions on nonnegative supports. The corresponding estimator is directed by a given parametric part, and a nonparametric part which is a weight function to be estimated through multivariate associated kernels. A diagnostic model is also discussed to make an appropriate choice between the parametric, semiparametric and nonparametric approaches. The retention of pure nonparametric means the inconvenience of parametric part used in the modelization. Multivariate real data examples in semicontinuous setup as reliability are gradually considered to illustrate the proposed approach. Concluding remarks are made for extension to other multiple functions. This is a joint work with Célestin C. Kokonendji; see [18].

Bayesian selector of global bandwidth for extended beta kernel estimator

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Bayesian bandwidth selections in associated kernel estimation of probability density function are known to improve classical methods as cross-validation techniques in terms of execution time and smoothing quality. In this paper, we propose a non-parametric density estimator based on continuous associated kernel and appropriated to estimate densities of support $[a, b]$ with $a, b \in \mathbb{R}$. For this purpose, we consider a Bayesian global estimation of the bandwidths parameters for beta extended kernel estimator using the quadratic loss functions. Simulations and real data sets studies show better performance of our approach, comparing with cross-validation bandwidth selection and under integrated squared errors. This is a joint work with Sobom M. Somé and Francial G. Libengué;

Approximately linear INGARCH models for spatio-temporal counts

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Models for count time series are often defined as counterparts to the well-known ARMA models, such as INARMA and INGARCH models (referred to as BINGARCH models if bounded counts), both having an ARMA-like ACF. Here, we are concerned with multivariate count data resulting from a spatio-temporal process. Although there also exist a few spatio-temporal modifications of INARMA models, most contributions are related to the more flexible INGARCH models. Among others, some

spatio-temporal INGARCH models for unbounded counts of infectious diseases have been proposed in the literature, where a conditionally linear structure is particularly relevant. But exactly linear model specifications go along with limiting parameter constraints that prevent negative parameter and ACF values. Thus, we consider two recent classes of approximately linear (B)INGARCH models, which allow for negative ACF values while (nearly) preserving the linear model structure. We combine the spatio-temporal and the approximately-linear (B)INGARCH approaches in a unique way to obtain a class of rather flexible spatio-temporal (B)INGARCH-type models. We discuss their stochastic properties and analyze the finite-sample performance of maximum likelihood estimation. The general need for modeling bounded spatio-temporal counts is illustrated with a couple of real applications from climatology. An example on the cloud coverage of the sky demonstrates that solutions for dealing with missing data are crucial. When modeling hourly precipitation, we have to account for zero-inflation, and data on daily measurements of precipitation are used to illustrate how additional cross-correlation might be included into our novel model families.

Generally-altered, -inflated, -truncated and -deflated negative binomial regression, with application to heaped and seeped data

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Zero-inflated and -altered (hurdle) Poisson regression are popular for accounting for excess and deficient zeros in count response data. Truncated (positive) Poisson regression is also popular. In this talk we propose GAITD regression to unify truncation, alteration, inflation and deflation simultaneously, e.g., to general sets rather than 0. Parametric and nonparametric alteration, inflation and deflation means our combo model has seven types of 'special' values. Using the negative binomial (NB) as the parent or base distribution, the GAITD-NB has potential to be the Swiss army knife of count distributions because it can handle underdispersion, equidispersion, and overdispersion relative to the Poisson, as well as spikes and dips at arbitrary values. In fact it can accommodate up to seven modes! GAITD regression rests upon a finite mixture model with nested support. This talk will give an overall of the methodology and its VGAM R package implementation which is available on CRAN; see [19].

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	Wednesday 06	Thursday 07	Friday 08
09:00	Célestin C. Kokonendji	Ad Ridder	Smail Adjabi
	Rahma Abid	Gérard Letac	SMS/WEW
10:30			
11:00	Pedro Puig	Farouk Mselmi	Naushad Namode Khan
	Rafael de Andrade Moral	Assi N'guessan	Thomas W. Yee
12:30	Lunches		
14:00	Christian H. Weiß	Marcelo Bourguignon	Besac City
	Johannes Bracher	Jean-François Dupuy	
15:30			
16:00	Feriel Bouhadjera	Youssef Esstafa	
	Yousri Slaoui	O. Hili/S. Chakraborty	
17:30			
20:15	Dinner *Chez Elle*		

Contents