10-Year-Track-Record

1. Top 10 publications

[1] with S. Louhichi. A new weak dependence condition and applications to moment inequalities. Stochastic Process. Appl. **84**-2, 313-342 (1999)
      [37 citations mathscinet, 137 Google Scholar]

[2] with C. Coulon-Prieur. A CLT for triangular arrays of weakly dependent sequences. Statist. Probab. Letters **47**-1, 61-68 (2000)
      [13 citations mathscinet, 24 Google Scholar]

[3] with J. Dedecker. A new covariance inequality and applications. Stochastic Process. Appl. **106**-1, 63-80 (2003)
      [21 citations mathscinet, 63 Google Scholar]

[4] with P. Ango Nze, P. Bühlmann. Weak dependence beyond mixing and asymptotics for non parametric regression. Ann. Statist. **30**-2, 397--430 (2002)
      [6 citations mathscinet, 28 Google Scholar]

[5] with P. Ango Nze, Weak dependence, models and applications to econometrics. Econometric Theory **20**-6, 995-1045 (2004)
      [4 citations mathscinet, 43 Google Scholar]

[6] with G. Lang, D. Surgailis, M. C. Viano. Functional limit theorem for the empirical process shifts with long memory. J. Theor. Probab. **18**-1, 161-186 (2005)
      [1 citation mathscinet, 9 Google Scholar]

[7] with M. Neumann. A Bernstein type inequality for times series, Stochastic Process Appl. **117**-7, 878-903 (2007)
      [14 citations Google Scholar]

[8] with J. M. Bardet, J. R. León. A uniform central limit theorem for the periodogram and its applications to Whittle parametric estimation for weakly dependent time series, J. Time Ser. Anal **29**-5, 906-945 (2008)
      [10 citations Google Scholar]

[9] with G. Lang, S. Louhichi, B. Ycart. A functional central limit theorem for interacting particle systems on transitive graphs. Markov Processes Relat. Fields **14**-1, 79-114 (2008)
      [6 citations Google Scholar]

[10] with O. Wintenberger. Weakly dependent chains with infinite memory, Stochastic Process Appl. **118**, 1997-2013 (2008)
      [2 citations mathscinet, 19 Google Scholar]
References here are more representative to my opinion, even if they are not always my most cited papers

2. Monographs and chapters of monographs

[1]   with P. Ango Nze. Weak dependence: models and applications, Dehling W. et al. (ed.), Empirical Processes Techniques for Dependent Data, 117-137 *Birkhäuser Boston, Boston* (2002)
      [6 citations mathscinet, 7 Google Scholar]

[2]   with G. Lang, D. Surgailis. Functional CLTs for short or long memory linear sequences. En l'honneur de J. Bretagnolle, D. Dacunha-Castelle, I. Ibragimov. Ann. Inst.Henri Poincaré B. 38-6, 879--896 (2002)
        [7 citations mathscinet, 17 Google Scholar]

[3]   Theory and Applications of Long-range Dependence, Paul Doukhan, Georges Oppenheim and Murad S. Taqqu editors (718 pages) Birkhaüser, Boston (2003)
        [272 citations Google Scholar]
Includes Models Inequalities and Limit Theorems for Stationary Sequences, 41-100 [9 citations mathscinet, 32 Google Scholar] and with A. Khezour, G. Lang. Non-parametric estimation for LRD sequences, 303-311
        [1 citation Google Scholar]

[4]   Dependence in Probability and Statistics, Patrice Bertail, Paul Doukhan, and Philippe Soulier (Editors.) LNS 187, Springer, New York (500 pages) (2006), includes P. Doukhan, G. Teyssière, and P. Winant. Vector valued ARCH infinity processes
        [4 citations mathscinet, 18 Google Scholar])

[5]   Weak dependence: models, theory and applications (350 pages), LNS 190, Springer-Verlag, with G. Lang, C. Prieur, S. Louhichi, J. Dedecker, J. R. León (2007)
        [7 cit. mathscinet, 19 cit. GS]

[6]   Dependence in Statistics and Econometry, Gabriel Lang, Paul Doukhan, Donatas Surgailis and   Gilles Teyssière (Editors) Springer, New York (2010).

[7]   with J. Jakubowicz, J. León. Subsampling an asymptotic variance, in Collective volume to the dedicated to Walter Philipps, Kendricks Press (2010).

4. Some selected invited presentations

9/2003 Workshop on CLT, in Prague, organized by P. Lachout

3/2004 IXth CLAPEM, Punta del Este Uruguay.

5/2004 Conference on times series in Graz, Austria, organized by I Berkes, L Horvath.

9/2004 University of Merida Vénézuéla: « Latino american school of mathematics »: course on weak dependence.

6/2006 Gnedenko Conference, Kiev.

7/2006 XXVI European Meeting of Statisticians, Torun

12/2006 Course on times series, La Habana, Cuba.

2/2007 X-th CLAPEM Lima.

5/2007 Conference on times series in Graz, Austria, organized by I Berkes, L Horvath.

3/2008 GOPS, Aachen.

5/2009 RoGer Symposium on Mathematics and Its Applications, Sibiu, Romania.

5/2009 Conference on times series, Debrecen, Hungary.

5/2009 Conference in the honour of Walter Philipp, Graz, Austria.

9/2009 WIN09, statistics for integer valued times series, Porto, Portugal.

8/2010 28th-European Meeting of Statistics, Piraeus, Greece.

9/2010 Prague Stochastics.

9/2010 Modern Stochastics, theory and applications II, Kiev.

6. Organization of conferences

6/2005 Organisation of a conference on dependence and applications in Paris with Patrice Bertail.
7/2006 XXVI European Meeting of Statisticians, Torun (invited session).
9/2006 Research days group MAS of SMAI, Modèles Spatiaux, Lille (organisation of a session).
5/2009 Invited session SFDS Bordeaux..
1/2010 Organization of a conference on times series, Cergy.
6/2010 Co-organization with J. M. Bardet, G. Lang, F. Merlevede of a conference dedicated to the 60th birthday of Magda Peligrad, Paris.
4/2011 Co-organization of a Workshop at CIRM, Marseille on limit theorems for dependent data, with Richard Bradley, Herold Dehling, Michael Neumann

Regularly invited in national and international institutes for post-graduate lectures, research work, and talks (mainly in Austria, Great Britain, Germany, Hungaria, Lituania, Nederland, Norway, Spain, Russia, Ukraine, Uruguay or Venezuela).
Organization of very regular local workshops and seminars in Cergy Pontoise university (statistics and dependence), ENSAE (on dependence), ENGREF-AGROPARITECH (on point processes).

8. Membership of editorial board.

2006-2010   Associate Editor, Stochastic Processes and their Applications.
2010   Associate Editor, Statistics.

Section 1d: *Extended Synopsis of the project proposal* (max 5 pages)
(see Guide for Applicants – Instructions for completing "Part B" of the proposal)

The present proposal is focused on the dependence of stochastic processes. Dependence of the time series is an essential feature of real applications. Very specific problems occur with this particular and natural property. Dependence under consideration concerns together time series, continuous time processes, random fields, or space-time processes. This means that random observations are respectively observed according discrete epochs like years or seconds, or continuously; and respectively observations are geographic (according to some graph relations) or even combining geographic and time indices.

The first and really important problem is the way to define the dependence conditions. In 1956 Pr. Murray Rosenblatt introduced a strong mixing condition extending on those from ergodic theory. The concept appears in ergodic theory and strong mixing techniques were introduced in order to takle statistical applications. A huge success of such notions is due to its simplicity and to the powerful range of mathematical applications of those notions. This *mixing* setting is widely used in Econometry. I also worked during years with those notions and Doukhan (1994) is among the most widely cited publications on mixing (789 citations on Google Scholar).

A very simple example of an autoregressive model with discrete inputs was exhibited in 1984 by Donald Andrews. I thus introduced a new and very simple notion of weak dependence in 1999 with Sana Louhichi. This frame is definitely a fruitful one as stressed in our collective volume Dedecker *et al.* (2007). I also introduced several nonlinear models exhibiting distributional long range dependence and the monograph Doukhan *et al.* (2003) is a main reference for long range dependence.

Limit theorems in probability theory under mixing and other dependence conditions are thus studied for the sake of applications. Problems related to the non-parametric estimation as well as fitting models to real data in statistics are among those applications. These and some other applications in finance and stochastic algorithms are already discussed in my preceding papers but there is still a number of open questions and unsolved problems concerning statistical inference and forecasting problems. The program in this proposition is to develop such applications for the next years.

Among the following important items the proposal is aimed at finding explicit solutions for applications for which a statistical dependence is relevant. This means that priority will be given to those applications without avoiding deep theoretical questions. More precisely the selected applications are essentially those for which improvements of the theory are really needed. Applications to Ecology (hydrology, disposition of the trees in a forest, trajectories of shoals of fishes and global warming), in biology (through sparsity techniques and applications to *DNA* codes), and to finance (through the estimation of extremes tails and the behaviour of high frequency data) will need much modelling efforts as well as many improvement of the statistical theory.

1 Modelling integer valued times series
The first important example from the application viewpoint is that of integer valued time series. Let us give some examples: in quality control when we observe the number of defective items found in successive samples taken from a production line; in epidemiology in identifying the numbers of cases of important diseases like *AIDS* in a given area in successive months; in road security surveillance, the number of deadly car accidents in successive weeks; in finance, the presence or absence of trading in a particular share on consecutive trading days. Monitoring of a specific disease is an important task in social and preventive medicine. Some integer-valued models have been used to represent times series like the fortnight number of campylobacter and

meningitis cases in a given area. See for example the models proposed by Ferland *et al.* (2006) or Doukhan *et al.* (2006). There exist regression models for time series of counts, see (Kedem and Fokanios, 2002, Chapter 4). Another point of view for defining discrete values processes is presented in Garcia *et al.* (2009) where applications to linguistic are also given. The models used here are infinite memory discrete time series which fit some weak dependence conditions.

2 Continuous time processes and random fields

Modelling *continuous times processes* with weak dependence properties is a real challenge of a current main interest. A special attention should be given to Lévy driven diffusion processes. Non-Markov models such as equations with delay driven with Lévy processes will also be proved to exist. They are extensions of discrete time series denoted *LARCH* models in Dedecker *et al.* (2007). A project submitted to the French Agency for Research is to detect the trajectories of shoal of fishes; such trajectories are modelled as discretely observed vector valued continuous time processes. Prediction is also a natural feature of this problem. Either short-range or long-range dependence may be exhibited. Hence this questions enlightens several problems: we first need to propose continuous times models with weak dependence; the question of defining vector valued long range dependence is the second important topic of the question. Models with continuous time of diffusions with jumps are adapted to deal with risk management. Inference and prediction of such data are clearly essential for financial purpose.

Prediction of space-time data. Random fields modelling is another problem of interest beyond Dobrushin type conditional models, in Doukhan and Truquet (2007) we present alternative models, solutions of intrinsic equations $X_t = F((X_{t-s})_{s \geq 0}, \epsilon_t)$. Coherent models with space-time indices will be introduced; their coherence should be of a physical origin. Applications to meteorology where many such models have been introduced will be a main subject. Namely the problem of global warming will be considered according to the ideas introduced for the simpler time dependent case.

3 Dependence and point processes

An item of research related with extremes is to investigate more accurately the dependence properties of point processes. Such models appear naturally, they denote a realization of points thrown on a plane according to distribution without finite limit points; the number of points is thus denumerable and observation is given in a bounded zone so that it is a finite random set. Besides the homogeneous Poisson process which correspond to an ideal independent situation, many types of Markov or compound point processes need to be considered (see Daley and Vere-Jones, 2003). Notions of dependence adapted to point processes are also needed. Applications to ecology problems may be found in Lang and Marcon (2010). General dependence conditions of point processes need to be introduced. Another project is concerned by a problem of ecology; the location of trees in a forest needs a description to be proposed as clustering models for forests. Intra and inter species are of a specific interest for ecological modelling. Such questions are addressed by the National Agency of Waters and Forests **(ENGREF).**

4 Long range dependence (LRD)

LRD phenomena were exhibited in Rosenblatt (1962). A main interest was stressed for the corresponding limit behaviours because of their fractal behaviour. Such processes were first used for modelling the fjords in Norway and Benoit Mandelbrot (1979) also used the first example of fractional Brownian motion to this aim. In this case the Hurst exponent determines also the regularity of trajectories. Hurst (1951) exponent was introduced in an hydrology problem in order to optimize the size of a reservoir. Analysis of stock exchange values also fits such fractal models. LRD is often assimilated with a short list of simple models, which are often not completely satisfactory. More complicate models are functions of linear processes and a nice treatment of their properties follows from Ho & Hsing (1997), the case of models $X_n = G(Y_n, \epsilon_n, \epsilon_{n-1}, \dots)$ excited by a linear process is processed in a join work with Lang and

Surgailis (2010). Such models are proved to follow a more specific type of asymptotic behaviour that the linear or Gaussian case. For those results, the existence of moments with order more than 2 has to be assumed. Heavy tailed *LRD* appears in the field of traffic in telecommunications (empirical studies prove that moments of order 2 are not finite), see Willinger *et al.* (1996); however traffic is a complex field where non-stationary, heavy-tails and external phenomena play competitive roles, moreover new questions such as streaming are now of a main importance and they seem hard to model here. Samorodnitsky and Taqqu (1994) propose a deep survey of this problem. An important paper for limit theory of partial sums in this case is Mikosch *et al.* (2002). Limit theory is considered for empirical cdf of linear processes in Surgailis (2002), and for some random *AR*-processes in Leipus *et al.* (2006); we also refer a very nice recent work by Bartkiewicz *et al.* (2009) but anyway few is known under general conditions even for this simple partial sums process. We aim at considering a more systematic class of such models.

5 Non stationarity

Non-stationarity may be modelled in different ways. A first way to model non-stationary times series is to write for some stationary times series (ξ_k) and two regular functions a, and b on the time interval $[0,1]$

$$X_k = a(j/n) + b(j/n)\xi_k \quad for \quad 1 \leq k \leq n$$

The estimation of those coefficients is based on local partial sums processes and other kernel-type methods and isotonic regression may also be used. Interesting situations appear when the error process ξ_k in this model is long range dependent. This often occurs when considering financial or climatology time series. For instance the annual series of winter means of the NAO index (North Atlantic Oscillation index) exhibits long range dependence (see Dedecker *et al.* 2009). Horvath also considered estimation for non stationary times series. More accurate models of non stationary processes will be developed together with asymptotic theory for extremes of such models. Moreover alternatives between non stationarity is an interesting other practical issue. Global warming is a main question and considering space-time dependence is thus natural way to visualize its progression and to help its comprehension.

6 A program of statistical data analysis

An important step is indeed to decide if data considered are *stationary* or not (and also to discuss the counter-hypothesis, weak dependence or long range dependence); then a simple transformation, maybe an affine one, will transform the data into a stationary time series. Dahlhaus (2009) proposed interesting views to this question extended in further work on progress by Neumann. The idea is to prove second order stationarity by considering the difference of an integrated local spectrum and the standard periodogram; null hypothesis leads to a statistical decision procedure. *Changes of regime* may also be analyzed through classical techniques or through Surgailis *et al.* (2008)'s *IR* statistics. *Testing LRD* versus *SRD* will be exhibited by using the very distinct behaviours of the empirical process under those two conditions.

Fitting dependent models: after this, one should select a suitable model (among all those previously defined) for the proposed data. *Resampling* and tests for goodness of fit test are useful to decide of a suitable model. *E.g.* a dependent analogue of Kolmogorov-Smirnov test based on the empirical cumulative function will be developed; in this dependent setting a main problem is that, contrarily to the independent case, the sup-bound of the limit process Z of the empirical central limit theorem admits a distribution which relies on the whole dependence structure of (X_t). Statistical validation of the model is provided through previously introduced questions (in particular *Whittle* estimator or QMLE will be investigated for the above mentioned models). In the continuous time case we will also need to validate *discretization* procedures. *Model selection techniques* classically based on concentration inequalities will be developed. Non parametric tests for goodness-of-fit will also be considered; subsampling techniques are essential to estimate the quantiles of this distribution.   *Prediction* will be processed through both regression estimation and quantile regression estimation.

7 Statistical applications

Limit asymptotic theory for various statistics of interest is often a difficult question, both from the theoretical and from the computational viewpoint. Bickel and Bühlmann (1999) (which is a real counterpart of Doukhan & Louhichi, 1999) provide tools in this direction by *bootstrapping time series*. Such methods seem useful for extremes, records, unit-root problems, or *U*-statistics; see Neumann and Paparoditis (2008). An alternative to bootstrap are the methods of *subsampling,* see Bertail *et al.* (2004). A smoothed version of subsampling adapted to work with weak dependence is presented in Doukhan *et al.* (2010); in this paper the example of subsampling for extremes is essential.

8 Stochastic Algorithms

Algorithms with dependent inputs were already discussed by Brandière and Doukhan (2004). An intensive use of such algorithms is necessitated for portfolio optimization. The topic *Randomized algorithms* has roots in computer science and applies to computer algorithms that, in addition to input, take a source of random numbers and make random choices during execution. For many problems, a randomized algorithm is the simplest or the fastest. Some randomized algorithms and probabilistic analysis for them is discussed by Klesov (2010).

The problem of *sparsity* has received a lot of attention in the last few years. There is no theoretical result on the *LASSO* (see Tibshirani, 1996) in the case where the data are dependent. However, these results can be easily obtained: the only use of the fact that the data are independent is in Bernstein's inequality. Using Bernstein's inequality for dependent data (see Doukhan and Neumann, 2006), this looks possible to generalize the results of Bickel *et al.* (2007) to the case of dependent data. However, it would be even more interesting and more difficult to study also the *LASSO* in the case of an auto-regression. A study of their asymptotic and non-asymptotic property is thus needed.

9 Finance and extremes of stationary sequences

Value-at-Risk *(VaR)* has been introduced from 1980s, in particular from 1987 market crash; it plays a central role in financial risk management and control. This risk measure is widely used not only to quantify the risk of financial portfolio losses but also to regulate the whole financial industry. In 1999, the Basel II Accord promoted the use of *VaR*. Most of the standard literature about extreme events assume independence (see *e.g.* Embrechts *et al.*, 1997). But, as illustrated by the recent financial crisis, such assumption is not reasonable. It is the reason why there exists an urgent need for introducing dependence to provide better risk control.

Extremes occur clearly in for financial or insurance purpose but many other type of applications like geophysics. Earthquakes or tsunami are at the origin of the theory of extremes; they will be investigated through questions arising from the petroleum industry. The exact distribution of the

supremum of specific random processes and fields is often a difficult question. Asymptotic theory of extreme values of a time series is thus useful. Additional assumptions on the regularity of tails of the underlying distributions and/or on the mixing allow one to evaluate precisely the distribution of a large sample of a times series. Referring to Leadbetter, Lingren and Rootzen (1983) the asymptotic behavior of times series is « the same as » for independent and identically distributed sequences under two assumptions **D'** and **D**; the first one is an anticluster condition while the second one is a « tail-mixing » assumption. Under an additional tail regularity assumption an affine transform of the sequence of maxima converges in distribution to a distribution depending on a Pareto parameter α and an extremal index θ. Anyway various models do not satisfy those conditions (see Hall *et al.* 2009), in particular for real data, and even in case all the conditions are well known complicated normalizations make the estimation of a quantile of extreme values quite numerically unstable. Moreover without any additional information one may address the estimation of the quantiles of such extremes (usually called as Values at Risk in Finance). Subsampling is a first useful tool for this topic but in Finance, sample sizes are often not large enough for such techniques (see Bertail *et al.*2004). A more adapted way to estimate such *VaR*'s is to use resampling for parametric times series models such as in Sixiang Cai's doctoral work. To this aim various steps are due. First a deep estimation work is essential. Second one estimates the residuals in order to run the resampled version of a times series model. Third one works out statistics of interest; in our case this is either extremes or higher order quantiles. The point process of exceedances is of a main interest. Indeed the interesting value is certainly a high order quantile, with level tending to 1 with the sample size, more that the extreme of a times series. A nice review book on extremes is the collective one edited by Andersen *et al*. (2009).

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