

# 1st Workshop on Time Series Analysis

*in Honour of Professor Mohamed BENTARZI*  
*USTHB, May 02, 2024*

## Program

- 8h30-9h00** Registration
- 9h00-9h30** Opening Ceremony
- 9h30-10h30** **Plenary 1:** Marc HALLIN, Nonparametric Multiple-Output Center-Outward Quantile Regression.  
**Chair:** Hafida GUERBYENNE
- 10h30-10h50** Tea-Coffee Break
- 10h50-11h50** **Plenary 2:** Hafida GUERBYENNE, Modèle logGARCH à volatilité stochastique.  
**Chair:** Marc HALLIN
- 11h50-12h30** **Bentarzi as a researcher: testimony**
- 12h30-14h00** Lunch Break
- 14h00-16h30** **Contributed Paper Session**  
**Chair:** Nadia RABEHI
- 14h00-14h20** Ahmed BENSALMA, Fractional Augmented Dickey-Fuller test, Fractional Phillips-Perron test and Fractional Kwiatkowski, Phillips, Schmidt et Shin test.
- 14h20-14h40** Abderrahim KESSIRA, Structure probabiliste d'une Classe de Modèles GARCH en Puissance Périodiques et à Seuil.
- 14h40-15h00** Chahrazed LELLOU, A Maximum Likelihood method for Estimating Markov-Switching Periodic GARCH Model.
- 15h00-15h20** Abderrahmen MANAA, On Periodic Zero-Inflated Poisson INAR(1) Model.
- 15h20-15h40** Fares OUZZANI, Periodic Binomial AR Models with Finite Support.
- 15h40-16h00** Mohamed SADOON, On Periodic Generalized Integer-Valued AR (p) Models: Inference, Modeling and Forecasting.
- 16h00-16h30** **WTSA'2024 Closing ceremony**



## Plenary I:

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### Nonparametric Multiple-Output Center-Outward Quantile Regression

Eustasio del BARRIO<sup>(1)</sup>, Alberto González SANZ<sup>(2)</sup> and Marc HALLIN<sup>(3)</sup>

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<sup>(3)</sup> ECARES and Département de Mathématique, Université libre de Bruxelles, Belgium.

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**Abstract:** Building on recent measure-transportation-based concepts of multivariate quantiles, we are considering the problem of nonparametric multiple-output quantile regression. Our approach defines nested conditional center-outward quantile regression contours and regions with given conditional probability content, the graphs of which constitute nested center-outward quantile regression tubes with given unconditional probability content; these (conditional and unconditional) probability contents do not depend on the underlying distribution—an essential property of quantile concepts. Empirical counterparts of these concepts are constructed, yielding interpretable empirical contours, regions, and tubes which are shown to consistently reconstruct (in the Pompeiu-Hausdorff topology) their population versions. Our method is entirely non-parametric and performs well in simulations—with possible heteroskedasticity and nonlinear trends. Its potential as a data-analytic tool is illustrated on some real datasets.

**Keywords:** Multiple-output regression; Center-outward quantiles; Optimal transport.

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## Plenary 2:

### Modèle logGARCH à volatilité stochastique

Hafida GUERBYENNE<sup>(1)</sup>, Fayçal HAMDİ<sup>(2)</sup> et Malika HAMRAT<sup>(1,3)</sup>

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**Résumé :** Une nouvelle classe de modèles à volatilité stochastique appelée logGARCH stochastic volatility models (logGARCH-SV), à coefficients invariants dans le temps, est introduite. Elle se distingue du modèle SV classique par le lien qui existe entre le processus observé et ses valeurs passées indirectement à travers les dynamiques de la log-volatilité. De façon spécifique, le logarithme du carré de l'observation passée est ajouté à la log-volatilité latente du modèle AR-SV classique afin d'en augmenter la flexibilité.

Les propriétés de stationnarité stricte et de stationnarité au second ordre sont établies. Les conditions d'existence de moments d'ordre supérieur sont obtenues. Pour estimer les paramètres, une méthode séquentielle de Monte-Carlo fondée sur le filtre particulaire a été adoptée. Une étude de simulation montre la performance de la méthode utilisée.

Une extension de cette classe de modèles, au cas où les coefficients évoluent de façon périodique dans le temps, sera également présenté.

**Mots clés :** Modèle logGARCH-SV, Modèle à volatilité stochastique, stationnarité, existence de moments d'ordre supérieur, structure d'autocorrélation, filtre particulaire, Algorithme EM.

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## Contributed Paper Session

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### Communication 1

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#### **Fractional Augmented Dickey-Fuller test, Fractional Phillips-Perron test and Fractional Kwiatkowski, Phillips, Schmidt et Shin test**

**Ahmed BENSALMA**

**LAMOPS Laboratory, Department of Statistics, ENSSEA, Koléa, Tipaza, Algeria**

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**Abstract:** Unit root tests are widely used in econometric analysis. These kinds of tests are traditionally constructed under  $I(1) - I(0)$  dichotomy, representing, first order integration series and covariance stationary series respectively. The best known unit root tests are the Dickey-Fuller test (*DF* test in short), the augmented Dickey-Fuller test (*ADF* in short), the Phillips and Perron test (*PP* test in short) and Kwiatkowski, Phillips, Schmidt et Shin test (*KPSS* test in short). With the advent of fractional integration theory, the conditions established by  $I(1) - I(0)$  paradigm becomes specific cases of extended  $I(d)$ , with  $d \in \mathbb{R}$ . The parameter  $d$ , called the fractional integration parameter, is known as "the long memory parameter". The general family of fractionally integrated processes is denoted  $FI(d)$ . The primary purpose of this communication is to suggest generalizations of the *ADF*, *PP* and *KPSS* tests to the fractional case, i.e. where the order of integration is fractional under the null hypothesis.

**Keywords:** Dickey-Fuller test; Augmented Dickey-Fuller test, Fractional Dickey-Fuller test; *KPSS* test, *PP* test, long memory processes, fractional integration.

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### Communication 2

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#### **Structure Probabiliste d'une Classe de Modèles GARCH en Puissance Périodiques et à Seuil**

**Hafida GUERBYENNE<sup>(1)</sup> et Abderrahim KESSIRA<sup>(2)</sup>**

<sup>(1)</sup> **Faculté de Mathématiques, USTHB, Alger, Algérie.**

<sup>(2)</sup> **École Nationale Supérieure de Mathématiques, Sidi Abdellah, Alger, Algérie.**

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**Résumé :** Dans ce travail, nous étudions une nouvelle classe de modèles conditionnellement hétéroscédastiques en puissance et à seuil, dont les coefficients sont évolutifs dans le temps de façon périodique. Ceci permet de prendre en charge à la fois l'effet du jour existant dans les séries de données financières ainsi que d'autres faits stylisés qui les caractérisent,

notamment, le regroupement de volatilité, l'effet de levier : la volatilité ayant une amplitude plus ou moins importante selon la tendance des cours boursiers en particulier. Des propriétés probabilistes telles que la stationnarité stricte, l'existence des moments d'ordres supérieurs et l'ergodicité géométrique ont été établies. L'ergodicité géométrique nécessite l'obtention de la condition de Foster-Lyapounov ainsi que la propriété de -irréductibilité de la chaîne de Markov sous-jacente. Cette propriété est obtenue par le biais de la condition d'additivité dénombrable uniforme.

**Mots clés :** Modèle GARCH à seuil, transformation en puissance, coefficients périodiques, moments, ergodicité géométrique,  $\beta$ -mélange, stationnarité stricte, condition d'additivité dénombrable uniforme.

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## Communication 3

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### A maximum likelihood method for estimating Markov-switching periodic GARCH Model

Fayçal HAMDJ and Chahrazed LELLOU

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**Abstract:** In this study, our focus is on estimating the Markov Switching Periodic GARCH (*MS-PGARCH*) model, characterized by time-varying parameters governed by a hidden Markov chain and a periodicity structure. This model not only captures stochastic regime switching commonly observed in financial time series analysis but also incorporates periodicity in the autocorrelation structure. This periodicity resembles deterministic regime changes, where the regime at any given time is predetermined. We propose a maximum likelihood estimation procedure based on a collapsing technique previously introduced in the literature. Our approach involves approximating the log-likelihood by truncating past trajectories up to a specified lag and employing the collapsed *MS-PGARCH* model. To evaluate the performance of our proposed method, we conduct a simulation study and compare it with the Generalized Method of Moments (*GMM*) approach. Additionally, we apply the *MS-PGARCH* model to analyze the log-return series of spot rates for the euro against the Algerian dinar.

**Keywords:** Markov switching GARCH model, periodicity, path dependence, collapsing procedure, maximum likelihood, exchange rates.

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## Communication 4

### On Periodic Zero-Inflated Poisson INAR(1) Model Abderrahmen MANAA<sup>(1)</sup> and Souakri ROUFAIDA<sup>(2)</sup>

<sup>(1)</sup> Higher National School of Biotechnology Taoufik Khaznadar, Constantine, Algeria.

<sup>(2)</sup> Faculty of Mathematics, USTHB, Algiers, Algeria.

**Abstract:** The modeling of integer-valued time series has received considerable attention, which has led to the introduction and in-depth study of various linear models to develop appropriate ones for such data. Among these models, the integer-valued autoregressive INAR model has been particularly prominent. However, this model fails to take adequate account of the periodic feature in the datasets. To address this limitation, we present in this communication a new model namely, the periodic integer-valued autoregressive model with a zero-inflated Poisson distribution innovation *PZIP-INAR(1)*. This model effectively captures the overdispersion resulting from an excessive number of zeros in periodic cases. Indeed, we provide clear definitions of the model and establish the periodic stationarity conditions. In addition, we derive explicit expressions for the periodic mean, variance, and autocovariance structure of the proposed model. The estimation problem is addressed via three different methods. The performance of these methods is thoroughly evaluated through intensive simulation studies and an application on real data by analyzing the daily number of COVID-19 deaths in Finland.

**Keywords:** Zero inflated Poisson distribution, Periodic *ZIP-INAR* model, COVID-19 deaths in Finland.

## Communication 5

### Periodic Binomial AR models with finite support Fares OUZZANI<sup>(1)</sup> and Mohamed SADOON<sup>(2)</sup>

<sup>(1)</sup> Research Center in Astronomy, Astrophysics and Geophysics, Algiers, Algeria.

<sup>(2)</sup> RECITS laboratory, Faculty of Mathematics, USTHB, Algiers, Algeria.

**Abstract:** We present in this work a periodic integer-valued time series model with finite support. This model is suitable for modeling phenomena involving counting on a finite range, such as the number of hospitalized persons. The presented model hereafter called the periodic binomial *AR* model (*PBAR*), can handle seasonal behavior in such phenomena. The main goal of this work is to

discuss some probabilistic properties including the periodic stationarity conditions and the closed form of the mean and the variance. Furthermore, aiming to estimate the model's parameters, two approaches are addressed, namely the Yule-Walker and the Conditional Maximum Likelihood. The performances of these procedures are shown through a simulation study.

**Keywords:** Integer-valued Autoregressive, Finite support models, Periodic time series models, Stationarity conditions, Parameters estimation.

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## Communication 6

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### On periodic generalized integer-valued AR (p) models: inference, modeling and forecasting

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**Abstract:** This contribution proposes a periodic integer-valued autoregressive model, based on generalized thinning operator (hereafter referred to as  $P$ -GINAR( $p$ )), to analyze the number of certain arrivals in a fixed time interval with seasonal behavior. We provide four statistical inference procedures, namely: three estimation methods including the conditional least squares (CLS) method, the conditional maximum likelihood (CML) method, and the local asymptotic minimax (LAM) method as well as a test procedure to test the periodicity. Moreover, the asymptotic properties of the estimators are established. For the forecasting issue, we propose the conditional expectation forecast method, the conditional median forecast method, and the efficient probabilistic forecast method.

Further, both the exact and the approximate  $h$ -step ahead conditional distribution of the model will be given using some parametric and non-parametric representations. The performances of the obtained inference procedures and predictors will be evaluated via an intensive simulation study and application on real data cases.

**Keywords:** Periodic GINAR( $p$ ) model, CLS and CML estimators, efficient estimators, conditional expectation and median forecast, efficient probabilistic forecasts, optimal test.