ITISE 2023

Gran Canaria (Spain)
12th-14th July 2023

ITISE-2023

PROGRAM
and
ABSTRACTS

11th-14th JULY, 2023
Gran Canaria (SPAIN)

ITISE-2023 Program

Tuesday, July 11th, 2023	
18:30-20:00	**REGISTRATION DESK** *(start at 18:30h but it is open during all the conference)*
18:30-20:00	**Upload the presentations to the room's computer (in case you haven't sent them by email).**

NOTES:

- All Sessions A will be held in Hotel Lopesan Villa del Conde Resort. They are **face-to-face sessions**, and they will also be shared on-line by Zoom. The **plenary lectures** are in **Session A.**
- All Sessions B and Sessions C will be held on-line (virtual) using Zoom.
- **Oral** Presentation: **15 minutes** (including the questions). Short Presentation: **12 minutes** (including the questions). Depending on whether there are absent speakers, times may be adjusted.
- **Poster** authors are requested to place their posters on the panels before the start of the poster session (e.g. morning posters can be placed before 10 o'clock, before the coffee break, and afternoon posters before 16:00. They can be placed on any of the panels). The morning posters should be removed at 14:30 and the afternoon posters at 19:45. It is recommended to use **A0 size** and large fonts.

Session A: Located in the last floor of the main building

	Wednesday, July 12, 2023		
8:30	**REGISTRATION DESK** *(start at 8:30h but it is open during all the conference)*		
	All **Sessions A: Oral face-to-face sessions**. All **Sessions B and C:** Oral (will be held on-line by Zoom)		
9:00-10:15	**Session A.1: Financial Forecasting and Risk Analysis (Part. I)**	**Session B.1: Advanced Econometric Methods for Economic Analysis and Finance**	**Session C.1: Data Preprocessing Methods in Time Series**
10:15- 11:00	**Session A.2: Deep Learning Methods in Time Series**	**Session B.2: Real Macroeconomic Monitoring and Forecasting**	
11:00-11:40	**COFFEE BREAK**		
11:00-14:30	**Session A.3: POSTER SESSION (A)**		
11:40-12:55	**Session A.4: Dimension Reduction Techniques**	**Session B.3: Energy Forecasting**	**Session C.2: Econometric Models and Forecasting** Short Presentation
13:00-14:00	**Session A.P1: Opening & Plenary Lecture. Prof. Daniel Peña Sánchez De Rivera** University Carlos III, Madrid (Spain)		
14:00-16:00	**REST BREAK**		
16:00-19:45	**Session A.5: POSTER SESSION (B)**		
16:00-17:30	**Session A.6: Energy Forecasting**	**Session B.4: Econometric Models**	**Session C.3: Time Series Analysis with Computational Intelligence**
17:40-19:55	**Session A.7: Applications in: Energy, Finance, Networks, Meteorology, Health, etc** Short Presentation	**Session B.5: Time Series Analysis with Computational Intelligence** Short Presentation	**Session C.4: Applications in: Energy, Finance, Networks, etc (Part I)** Short Presentation

	Thursday, July 13th, 2023		
8:45	**REGISTRATION DESK** *(start at 8:45h but it is opened during all the conference)*		
	All **Sessions A: Oral <u>face-to-face sessions</u>**. All **Sessions B and C:** Oral (will be held on-line by Zoom)		
9:00-9:45	**Session A.8: Forecasting Financial Markets**	**Session B.6: Econometric Forecasting**	**Session C.5: Applications in: Energy, Finance, Networks, Meteorology, Health, etc (Part II)**
9:45- 10:45	**Session A.9: Time Series Analysis with Computational Intelligence (Part I)**		
10:45-11:15	**COFFEE BREAK**		
11:00-14:30	**Session A.10: POSTER SESSION (C)**		
11:15-12:00	**Session A.11: Time Series Analysis with Computational Intelligence (Part II)**	**Session B.7: Health Forecasting**	**Session C.6: Forecasting Performance Evaluation**
12:00-13:00	**Session A.12: Econometric Models**	**Session B.8: Advances in Time Series Analysis and Forecasts in Engineering Sciences**	**Session C.7: Artificial Intelligence and Sustainability**
13:00-14:00	**Session A.P2: Plenary Lecture. Prof. Martin Wagner University of Klagenfurt, Chief Economic Advisor at the Bank of Slovenia**		
14:00-16:00	**REST BREAK**		
16:00-17:00	**Session A.13: Advances in Time Series Analysis and Forecasts in Engineering Sciences**	**Session B.9: Forecasting performance evaluation**	**Session C.8: : Health Forecasting**
17:05-19:30	**Session A.14: New Advances in Time Series Analysis and Forecasting (Part I)** Short Presentation	**Session B.10: Applications in: Energy, Finance, Transportation, Networks, etc** Short Presentation	**Session C.9: New Advances in Time Series Analysis and Forecasting (Part II)** Short Presentation
20:30	**GALA DINNER Hotel Lopesan Baobab 5* (15 minutes walking from Hotel Lopesan Villa del Conde Resort)**		

	Friday, July 14th, 2023	
8:45	**REGISTRATION DESK** *(start at 8:45h but it is opened during all the conference)*	
	All **Sessions A: Oral** <u>face-to-face sessions</u>. All **Sessions B:** Oral (will be held on-line by Zoom)	
9:00-10:15	**Session A.15: Advanced Econometric Methods for Economic Analysis and Finance**	**Session B.11: Forecasting Financial Markets**
10:15- 11:00	**Session A.16: Financial Forecasting and Risk Analysis (Part. II)**	**Session B.12: New Advances in Time Series Analysis and Forecasting**
11:00-11:30	**COFFEE BREAK**	
11:30-12:45	**Session A.17: Real Macroeconomic Monitoring and Forecasting**	**Session B.13: Deep Learning Methods in Time Series**
12:45-13:30	**Session A.18: New Advances in Time Series Analysis and Forecasting (Part II)**	
13:30-14:30	**Session A.P3: Plenary Lecture.** **Prof. Eamonn Keogh** **Distinguished Professor, Department of Computer Science and Engineering** **University of California Riverside**	

ITISE 2023 PROGRAM

Wednesday, July 12, 2023

(9:00-10:15) Session A.1: Financial Forecasting and Risk Analysis (Part. I)

Chairman: Dr. Benita Zulch and Dr. Magdalena Szyszko

Detecting superexponential behaviour in financial asset price returns with applications to trading strategies (**Ref:** *2668*)

Christopher Lynch and Ben Mestel

Forecasting Day-ahead Expected Shortfall on the EUR/USD Exchange Rate: The (I)relevance of Implied Volatility (**Ref:** *1364*)

Tomáš Plíhal, Štefan Lyócsa and Tomáš Výrost

Risk-adjusted Returns of Croatian Largest Manufacturers and Their Determinants (**Ref:** *2992*)

Tomislava Pavic Kramaric, Maja Pervan, Ivica Pervan and Ivan Pavic

Usage of portfolio replication in non-life insurance (**Ref:** *4189*)

Petr Vejmělka and Tomáš Cipra

Functional Profile Methods for Structured Missing Not at Random Data (**Ref:** *6517*)

Matus Maciak, Ivan Mizera and Michal Pesta

(10:15-11:00) Session A.2: Deep Learning Methods in Time Series

Chairman: Dr. Sarah Diefenbach and Dr. Eros Gian Alessandro Pasero

Non-Invasive Arterial Blood Pressure Estimation from ECG and PPG Signals using a Conv1D - BiLSTM Neural Network (**Ref:** *5166*)

Federico Delrio, Vincenzo Randazzo, Giansalvo Cirrincione and Eros Pasero

A deep learning model for generalised surface water flooding across multiple return periods (**Ref:** *5558*)

Syed Kabir, David Wood and Simon Waller

A Deep Learning model based on Multi-Head Attention for long-term forecasting of solar activity (**Ref:** *8377*)

Giovanna Jerse, Valentina Alberti, Adriana Marcucci, Isacco Zinna and Mauro Messerotti

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(11:00-14:30) Session A.3: POSTER SESSION (A)

Chairman: Dr. Ignacio Rojas

Air Quality Early Warning System for Delhi: wintertime meteorology and particulate matter (PM2.5 and PM10) (**Ref:** *1124*)

Prafull Yadav, Aditya Sengupta, Sachin Ghude and Gaurav Govardhan

Defining Sports Performance by Using Automated Machine-Learning System (**Ref:** *1543*)

Kalle Saastamoinen, Tuomas Alanen, Pasi Leskinen, Kai Pihlainen and Joona Jehkonen

Sim-to-Real Transfer in Deep Learning for Agitation Evaluation of Biogas Power Plants (**Ref:** *1590*)

Andreas Heller, Peter Glösekötter, Sven Annas, Lukas Buntkiel and Sebastian Reinecke

An evaluation of the past and future expected wind climate in the Mediterranean and the Black Seas (**Ref:** *2058*)

Eugen Rusu

Could data frequency imply better forecast performance for stock markets? A case study for G7 economies (**Ref:** *2421*)

Diana Mendes, Nuno Ferreira and Vivaldo Mendes

Assessment of minimum water level in Lake Volvi based on morphological and hydrological features (**Ref:** *2459*)

Charalampos Doulgeris and Rafaela Nikolaidou

Forecasted Self: AI-Based Careerbot - Service Helping Students in Job Market Dynamics (**Ref:** *2566*)

Asko Mononen, Ari Alamäki, Janne Kauttonen, Aarne Klemetti, Anu Passi-Rauste and Harri Ketamo

A combination of visible and infrared sky camera for improving cloud detection and forecasting (**Ref:** *2829*)

Joaquín Alonso-Montesinos

Nexus between Economic Growth and Health Indicators: Evidence from Pakistan (**Ref: *3597***)

Nadeem Malik and Reema Gulzar

Noise in GPS-DORIS co-located station position time series (**Ref: *3867***)

Sofiane Khelifa

Dust forecast during FIFA world cup Qatar 2022 (**Ref: *4272***)

Rajmal Jat, Prafull P. Yadav, Gaurav Govardhan, Krishna Kumar Kanikicharla and Sachin D. Ghude

Predictive Accuracy of Logit Regression for Data-Scarce Developing Markets: A Nigeria & South Africa Study (**Ref: *4445***)

Jonathan Oladeji, Benita Zulch and Joseph Yacim

Productivity loss related to premature cancer mortality in Brazil in three decades (2001-2030) (**Ref: *4479***)

Marianna De Camargo Cancela, Jonas Eduardo Monteiro dos Santos, Leonardo Borges Lopes de Souza, Luís Felipe Leite Martins, Dyego Souza, Anton Barchuk, Paul Hanly, Linda Sharp, Alison Pearce and Isabelle Soerjomataram

Simulation of the Queue Situation of Patients in the Health Center (**Ref: *4830***)

Kalle Saastamoinen, Antti Rissanen, Juho Suni, Juho Hyttinen, Petteri Paakkunainen and Aaro Liakka

Improving the Accuracy of Firm Failure Forecasting Using Non-Financial Variables: The Case of Croatian SME (**Ref: *5887***)

Tamara Kuvek, Ivica Pervan and Maja Pervan

Shock transmissions between crude oil prices, renewable energy stocks and sectoral indices (**Ref: *8567***)

Ana Escribano, Francisco Jareño and Monika Koczar

(11:40-12:55) Session A.4: Dimension Reduction Techniques

Chairman: Dr. Liliana Rusu

Garch-type Factor Model (**Ref: *2950***)

Chi Tim Ng

Reduced Order Modeling with Skew-Radial Basis Functions for Time Series Prediction (**Ref: *629***)

Manuchehr Aminian and Michael Kirby

Data-driven spatio-temporal modelling and optimal sensor placement for digital twin set-up. (**Ref:** *6854*)

　Mandar Tabib, Adil Rasheed, Kristoffer Skare and Endre Bruaset

Modelling High-dimensional Time Series with Nonlinear and Nonstationary Phenomena for Landslide Early Warning and Forecasting (**Ref:** *7299*)

　Hangfei Zheng, Guoqi Qian and Antoinette Tordesillas

Model Structure Determination for Sparse ARDL Models under High Dimensional Design Matrices (**Ref:** *8785*)

　Livio Fenga

(13:00-14:00) Opening Ceremony. Plenary Talk: Prof. Daniel Peña Sanchez De Rivera
Professor at Universidad Carlos III de Madrid.

Title of the presentation: Finding the Number of Clusters in Time Series

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(16:00-19:45) Session A.5: POSTER SESSION (B)

Chairman: Dr. Ignacio Rojas

Improving predictive accuracy in the context of dynamic modeling of non-stationary time series with outliers (**Ref:** *1412*)

　F. Catarina Pereira, A. Manuela Gonçalves and Marco Costa

Adjustment of Gauss-Helmert Models with Gaussian Errors and Data Gaps (**Ref:** *1424*)

　Prof. Boris Kargoll, Dr. Mohammad Omidalizarandi and Pd Dr. Hamza Alkhatib

The prediction of body composition with extracted features from a chest-worn personal monitoring device (**Ref:** *3501*)

　Seung Min Lee, Soon Bin Kwon and Hyung-Jin Yoon

Integrating weather and satellite data to model the effect of drought extremes on wheat response using time series analysis (**Ref:** *5193*)

　Tom Vanwalleghem and Vanesa Garcia

GPU-APUMPEDI: A Parallel Algorithm for Computing Approximate Pan Matrix Profiles of Time Series (**Ref: *5513***)

Jing Zhang, Daniel Nikovski and Takaaki Nakamura

Global forecasting models: Normalization methods for heterogeneous time series panel data (**Ref: *5904***)

Oskar Triebe, Leonie Freisinger and Christoph Bergmeir

Forecasting transitions in digital society: From social norms to AI applications (**Ref: *5966***)

Daniel Ullrich and Sarah Diefenbach

Forecasting inflation in turbulent environment. The case of Poland and Ukraine (**Ref: *5978***)

Magdalena Szyszko, Aleksandra Rutkowska and Olena Motuzka

Application of artificial intelligence methods for predicting the compressive strength of green concretes with rice husk ash (**Ref: *6117***)

Miljan Kovačević, Silva Lozančić, Marijana Hadzima-Nyarko, Ivanka Netinger Grubeša and Dorin Radu

Club classification of foreclosures rates in Spain (**Ref: *6155***)

Rafael González-Val and Miriam Marcén

Time-Frequency varying estimation of Okun Law a wavelets-based approach (**Ref: *7004***)

Roman Mestre

Measuring the impact of climate transition risk in the systemic risk: a multivariate quantile-located ES approach (**Ref: *7008***)

Laura Garcia-Jorcano and Lidia Sanchis-Marco

Projections of the climate change impact on the sea state conditions of the Black Sea (**Ref: *7414***)

Liliana Rusu

Nonstationary Frequency Analysis of Extreme Rainfall in the Taihu Lake Basin, China (**Ref: *7603***)

Yuting Jin, Shuguang Liu, Zhengzheng Zhou, Qi Zhuang and Guihui Zhong

Categorical Data Encoding Techniques for Recursive Multi-Step Prediction of Vessel Trajectory (**Ref: *7920***)

Robertas Jurkus, Julius Venskus and Povilas Treigys

Impact of oil and energy prices on inflation and inflation expectations: comparison of COVID-19 and war periods (**Ref:** *7952*)

Agata Kliber and Magdalena Szyszko

Time series forecasting by combining LSTM RNN and ARIMA (**Ref:** *7966*)

Akvilina Akstinait and Roberto Henriques

(16:00-17:30) Session A.6: Energy Forecasting

Chairman: Dr. Camel Tanougast

Exploring Uncertainty Intervals and Characteristics in Time Series Prediction: Incorporating Data Uncertainty and Interpretability (**Ref:** *4496*)

Direnc Pekaslan, Christian Wagner and Jonathan M. Garibaldi

The time-frequency nexus between energy supply, debt and growth for OECD European Countries (**Ref:** *295*)

Roman Mestre and Mohamed Awada

Probability Density-Based Energy-Saving Recommendations for Household Refrigerating Appliances (**Ref:** *3017*)

Francisco Rodríguez-Cuenca, Eugenio Francisco Sánchez-Úbeda, José Portela, Antonio Muñoz, Victor Guizien, Andrea Veiga Santiago and Alicia Mateo González

Analysis of long-term effects of the restrictions on trade with Russia using the TEMOA-Europe energy system optimization model (**Ref:** *6562*)

Daniele Lerede, Gianvito Colucci, Valeria Di Cosmo, Matteo Nicoli and Laura Savoldi

Medium Term Horizon Time Photovoltaic Power Generation Prediction for an Island Zone (**Ref:** *6750*)

Harry Ramenah, Camel Tanougast, Nidhal Rezg and Abdel Khoodaruth

Trading on short-term path forecasts of intraday electricity prices (**Ref:** *8009*)

Tomasz Serafin, Grzegorz Marcjasz and Rafał Weron

(17:40-19:55) Session A.7: Applications in: Energy, Finance, Networks, Meteorology, Health, etc (Short Presentation)

Chairman: Dr. Ignacio Rojas

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An intraday portfolio performance analysis of cryptocurrencies as diversifiers for Forex investors (**Ref:** *9126*)

  Carlos Esparcia and Raquel López

Banking sector development and economic growth in developing countries. Does the change in the shadow economy matter? A Nonlinear Panel ARDL (**Ref:** *1368*)

  Khalil Mhadhbi

Using Risk Terrain Modeling for the risk assessment of explosive ATM attacks (**Ref:** *2177*)

  Katharina Schwarz and Kai Seidensticker

Online Adaptive Bagging for Multivariate Time Series Forecasting (**Ref:** *783*)

  Amal Saadallah and Hanna Mykula

Goal-Oriented Transformer to Predict Context-aware Trajectories in Urban Scenarios (**Ref:** *1972*)

  Álvaro Quintanar, Rubén Izquierdo, Ignacio Parra and David Fernández-Llorca

A Comparison between successive Estimate of TVAR(1) and TVAR(2) and the Estimate of a TVAR(3) Process (**Ref:** *7064*)

  Johannes Korte, Jan Martin Brockmann and Wolf-Dieter Schuh

Opportunistic Scheduling-based forecasting Strategies for Efficient Resource Utilization in New Telecommunication Networks (**Ref:** *8684*)

  Mohamed Ouwais Kabaou, Nesrine Zoghlami, Fatma Baabou and Hassen Hamouda

Analyzing Mobility Patterns of Complex Chronic Patients Using Wearable Activity Trackers: A Machine Learning Approach (**Ref:** *1825*)

  Alejandro Polo Molina, Eugenio Francisco Sánchez Úbeda, José Portela González, Rafael Palacios Hielscher, Carlos Rodríguez-Morcillo García, Antonio Muñoz San Roque, Celia Álvarez Romero and Carlos Hernández Quiles

Growth curves modelling and its application (**Ref:** *9416*)

  Ana García Burgos, Beatriz Gonzáles Alzaga, María José Jiménez Asensio, Marina Lacasaña Navarro, Nuria Rico Castro and Desirée Romero Molina

EEG-Based Neural Synchrony Predicts Evaluative En-gagement with Music Videos (**Ref:** *2997*)

  Nikki Leeuwis and Tom van Bommel

Score-Driven Model for Dynamic Rankings: Methodology, Implementation, and Applications (**Ref:** *3922*)

    Vladimír Holý

Yearly Residential Electricity Forecasting Model based on Fuzzy Regression Time Series in Indonesia (**Ref:** *9311*)

    Riswan Efendi

Thursday, July 13th, 2023

(9:00-9:45) Session A.8: Forecasting Financial Markets

Chairman: Dr. Petr Hajek

Hierarchical Fuzzy Rule-Based Forecasting of Stock Prices using News Sentiment and Topic Detection (**Ref:** *1041*)

Petr Hajek

Stock Embeddings: Representation Learning for Financial Time Series (**Ref:** *4502*)

Rian Dolphin, Barry Smyth and Ruihai Dong

A Measure of Bivariate Long Memories in Stock Returns (**Ref:** *4812*)

Charles Mutigwe

(9:45-10:45) Session A.9: Time Series Analysis with Computational Intelligence (Part I)

Chairman: Dr. Ebrahim Ghaderpour and Kalle Saastamoinen

Recurrent Forecasting in Singular Spectrum Decomposition (**Ref:** *3701*)

Maryam Movahedifar, Hossein Hassani and Mahdi Kalantari

Efficient Forecasting of Large Scale Hierarchical Time Series via Multilevel Clustering (**Ref:** *1325*)

Xing Han, Tongzheng Ren, Jing Hu, Joydeep Ghosh and Nhat Ho

Online Pentanes Concentration Prediction System based on Machine Learning Techniques (**Ref:** *4550*)

Diana Manjarres, Erik Maqueda and Itziar Landa

Intrinsic Explainable Self-Enforcing Networks using the ICON-D2-Ensemble Prediction System for Runway Configurations (**Ref:** *5909*)

Dirk Zinkhan, Anneliesa Greisbach, Björn Zurmaar, Christina Klüver and Jürgen Klüver

(11:00-14:30) Session A.10: POSTER SESSION (C)

Chairman: Dr. Ignacio Rojas

Study on the probability of occurrence of wind energy generation given the wind speed: An Analysis Via Theo-ry of Copulas (**Ref:** *290*)

   Tuany Esthefany Barcellos de Carvalho Silva Tuany, Reinaldo Castro Souza Reinaldo and Marco Aurélio Sanfins Marco Aurélio

Learning Local Patterns of Time Series for Anomaly Detection (**Ref:** *615*)

   Kento Kotera, Akihiro Yamaguchi and Ken Ueno

Applying Data Mining and Machine Learning Techniques to Predict Powerlifting Results (**Ref:** *2175*)

   Jorge Medina Romero, Antonio Mora García, Juan Francisco Valenzuela Valdés and Pedro Castillo Valdivieso

Gaussian kernel estimator and bootstrap confidence intervals for correlation between time series sampled on different time points (**Ref:** *5798*)

   Mario Trottini, Isabel Vigo, Juan A. Vargas, David García-García and Jose Fernandez

Assessment of wave energy availability in the Romanian nearshore of the Black Sea (**Ref:** *7975*)

   Sorin Ciortan

Time series analysis in hydrogeological conceptual model upgrading (**Ref:** *8352*)

   Paola Gattinoni

Prediction of birch and ragweed pollination season in northeastern part of Croatia in a changing climate (**Ref:** *8354*)

   Edita Stefanic, Alka Turalija and Marin Lukacevic

Probabilistic Forecasting with Innovations: a deep-learning approach to nonparametric forecasting (**Ref:** *8367*)

   Lang Tong, Qing Zhao, Xinyi Wang and Men-Jen Lee

Wind Energy Turbines Assessment Regarding to the Wind and Price Instability (**Ref:** *8369*)

   Doron Greenberg, Michael Byalsky and Asher Yahalom

Energy transition in the U.S. commercial real estate: a diffusion comparison with the industrial sector. (**Ref:** *8415*)

   Andrea Savio

Revisiting The Dating of Financial Bubbles Via False Discovery Rate (**Ref:** *8479*)

   Gianmarco Vacca, Giulia Genoni and Piero Quatto

ICTs and Economic Growth: The case of South Africa (1990 to 2021) (**Ref:** *8953*)

   Simion Matsvai, Amon Taruvinga and Willie Chinyamurindi

Forecasting Short-Term Dredging Needs with Machine Learning Models at Southwest Pass (**Ref: *9310***)

Magdalena Asborno, Jacob Broders, Kenneth Mitchell, Michael Hartman and Lauren Dunkin

Multifractal organization of EEG signals in Multiple Sclerosis (**Ref: *9419***)

Marcin Wątorek, Wojciech Tomczyk, Magda Gawłowska, Jeremi Ochab and Paweł Oświęcimka

Structure Determination for Sparse ARDL Models under High Dimensional Design Matrices (**Ref: *9493***)

Livio Fenga

Impact of migration processes on GDP (**Ref: *9502***)

Olena Rayevnyeva, Kostyantyn Stryzhychenko and Silvia Matúšová

Forecasting and Explaining Infant and Youth Mortality in Portugal (**Ref: *9618***)

Rodrigo Ventura, Filipe Santos, Ricardo Magalhães, Cátia Salgado, Matilde Rosa, João Sousa and Susana Vieira

Competition in the Slovak Mobile Telephony Industry: Effects of new entry (**Ref: *9648***)

Jakub Čihák

Update of the strain rates of the Galera and Baza faults from GPS position time series in the period 2009 - 2020 (**Ref: *9729***)

Antonio J. Gil-Cruz, María Jesús Borque-Arancón, Manuel Avilés, Jesús Galindo-Zaldívar, Pedro Alfaro, Francisco J. García-Tortosa, Alberto Sánchez-Alzola, Iván Martín-Rojas, Iván Medina-Cascales, Patricia Ruano, Víctor Tendero, Asier Madarieta-Txurruka and Mayte Pedrosa

Application of machine learning in modeling the relationship between catchment attributes and in-stream water quality (**Ref: *9913***)

Miljan Kovačević, Silva Lozančić, Marijana Hadzima-Nyarko, Bahman Jabbarian Amiri, Dorin Radu and Emmanuel Karlo Nyarko

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(11:15-12:00) Session A.11: Time Series Analysis with Computational Intelligence (Part II)

Chairman: Dr. Tom Vanwalleghem

Moving Object Path Prediction in Traffic Scenes Using Contextual Information (**Ref: *6760***)

Jaime Boanerjes Fernandez Roblero, Suzanne Little and Noel E. O'Connor

Precipitation Time Series Analysis and Forecasting for Italian Regions (**Ref: *7068***)

Ebrahim Ghaderpour, Hanieh Dadkhah, Hamed Dabiri, Francesca Bozzano, Gabriele Scarascia Mugnozza and Paolo Mazzanti

Downscaling Fusion Model for CMIP5 Rainfall Projection under RCP Scenarios: the Case of Trentino-Alto Adige (**Ref: *8470***)

Amir Aieb, Antonio Liotta and Ismahen Kadri

(12:00-13:00) Session A.12: Econometric Models

Chairman: Dr. Marta Tolentino García-Abadillo and Dr. M$^{\underline{a}}$ Del Valle Fernández

A note on testing for threshold non-linearity in presence of heteroskedasticity in time series (**Ref: *4538***)

Greta Goracci and Simone Giannerini

Trends and cycles during the COVID-19 pandemic period (**Ref: *5029***)

Jose R Maria and Paulo Júlio

Analysis of diversification in investment portfolios Return and Risk for different time horizons (**Ref: *9544***)

Marta Tolentino, María del Valle Fernández, Sergio Fanega and María de La O González

Examining the Dynamic Connectedness Between Crude Oil Price Shocks and US Sector Indices (**Ref: *7655***)

M. Caridad Sevillano, Francisco Jareño, Raquel López and Carlos Esparcia

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(13:00-14:00) Plenary Talk:
Prof. Martin Wagner
University of Klagenfurt
Chief Economic Advisor at the Bank of Slovenia.

Title of the presentation: Sources and Channels of Nonlinearities and Instabilities of the Phillips Curve: Results for the Euro Area and Its Member States

Karsten Reichold, Martin Wagner, Milan Damjanovic, Marija Drenkovska

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(16:00-17:00) Session A.13: Advances in Time Series Analysis and Forecasts in Engineering Sciences

Chairman: Dr. Ullrich Daniel and Dr. Joao Sousa

Automating the work of the planners in reaching a consensus forecast in the sales operations planning (SOP) process **(Ref: *102*)**

Gabriel David Pinto and Roei Aviram

Sensor virtualization for anomaly detection of turbo-machinery sensors - An industrial application **(Ref: *1045*)**

Sachin Shetty, Valentina Gori and Giacomo Veneri

Forecasting for circular operations: Net-demand characterisation and forecast accuracy measurement **(Ref: *2984*)**

Thanos Goltsos

Prediction of dropping out of academic studies after the first semester of the first year **(Ref: *156*)**

Ron Weitzman and Gabriel David Pinto

(17:05-19:30) Session A.14: New Advances in Time Series Analysis and Forecasting (Short Presentation)

Chairman: Dr. Ivor Cribben and Dr. Saeed Heravi

Forecasting System for Inbound Logistics Material Flows at an International Automotive Company **(Ref: *903*)**

John Anderson Torres Mosquera, Carlos Julio Vidal Holguín, Alexander Kressner and Edwin Loaiza Acuna

The relationship between work engagement and demographic characteristics in the automotive industry **(Ref: *1048*)**

Pieter Smit, Cecile Schultz and Lize Van Hoek

Extreme Characteristics of Stochastic Non-Stationary Duffing Oscillators (**Ref: *3634***)
  Samuel Edwards, Matthew Collette and Armin Troesch

Ecological Forecasting (**Ref: *3791***)
  Yiqi Luo

Increasing the Performance and Plausibility of Machine Learning via Data Analysis Techniques (**Ref: *3843***)
  Silas Aaron Selzer, Fabian Bauer and Peter Bretschneider

Statistical haplotypes based on Functional Sequence Data Analysis for Genome-Wide Association Studies (**Ref: *8133***)
  Pei-Yun Sun and Guoqi Qian

A Semi-parametric Transition model For Lifetime Drift of Discrete Electrical Parameters in Semiconductor Devices using Accelerated Stress Test Data (**Ref: *9119***)
  Lukas Sommeregger and Horst Lewitschnig

Forecasting Industrial Production Using the State Dependent Models (**Ref: *9604***)
  Saeed Heravi and Bo Guan

Novel high dimensional time series methods (**Ref: *1610***)
  Ivor Cribben

Detection of instabilities in time dependent functional profiles (**Ref: *9349***)
  Matus Maciak and Sebastiano Vitali

Optimising the determinants of liquidity risk: UAE's Emirates Islamic Bank (**Ref: *6051***)
  Dr. Elias Abu Al-Haija and Aruna M

Friday, July 14th, 2023

(9:00-10:15) Session A.15: Advanced Econometric Methods for Economic Analysis and Finance

Chairman: Dr. Jean-Philippe Boucher

Novel estimators of the Ornstein-Uhlenbeck process using high-frequency data (**Ref:** *4932*)

Petra Tomanová, Vladimír Holý and Michal Černý

Uncertainty in Systemic Risks Rankings: Bayesian and Frequentist Analysis (**Ref:** *835*)

Elena Goldman

A Generalized Bonus-Malus Scales Model for Insureds of Different Sizes (**Ref:** *2709*)

Jean-Philippe Boucher

Improved prediction of Norwegian consumption by adjusting for temporary fluctuations in dividend income (**Ref:** *2890*)

Håvard Hungnes

Interest Rate Sensitivity of the largest European Pharmaceutical Companies. An Extension of The Fama and French Five-Factor Model (**Ref:** *6154*)

Maria De La O Gonzalez Perez and Francisco JareÑo CebriÁn

(10:15-11:00) Session A.16: Financial Forecasting and Risk Analysis (Part. II)

Chairman: Dr. Michal Cerny

Macroeconomic Adverse Selection in Machine Learning Models of Credit Risk (**Ref:** *4977*)

Joseph Breeden and Yevgeniya Leonova

Time Series Forecasting Case Study on Risk-based Asset Integrity Management for Low Voltage Failures of Power Distribution Systems (**Ref:** *7254*)

Sakura Attanayake and R.M. Chandima Ratnayake

Fuzzy combining forecasts instead of lag length selection in predicting price move direction (**Ref:** *8807*)

Aleksandra Rutkowska and Jakub Morkowski

(11:30-12:45) Session A.17: Real Macroeconomic Monitoring and Forecasting

Chairman: Dr. Giovanni De Luca

Exploring Hidden Patterns in Macroeconomic Data Series with the Fast Iterative Filtering Algorithm **(Ref: *1210*)**

Audrey De Dominicis, Paolo Canofari, Antonio Cicone, Giovanni Piersanti and Mirko Piersanti

(A)symmetric pass-through from oil and natural gas prices to consumer price indices in European countries: some recent empirical evidence **(Ref: *3011*)**

Ekaterini Tsouma and Yannis Panagopoulos

Assessing the Accuracy of Directional Forecasts **(Ref: *7500*)**

Constantin Burgi

Uncertainty and Business Cycle: an empirical analysis for Uruguay **(Ref: *7595*)**

Joaquín Torres, Bibiana Lanzilotta, Gabriela Mordecki and Pablo Tapie

(12:45-13:30) Session A.18: New Advances in Time Series Analysis and Forecasting (Part II)

Chairman: Dr. Hector Pomares

Analysis of Fermi-LAT blazar lightcurves in the time domain using Singular Spectrum Analysis **(Ref: *7505*)**

Alba Rico Rodríguez, Alberto Domínguez, Pablo Peñil, Sara Buson, Marco Ajello, Margherita De Toma and Sagar Adhikari

Probabilistic forecast reconciliation: cross-temporal framework **(Ref: *4664*)**

Daniele Girolimetto, George Athanasopoulos, Tommaso Di Fonzo and Rob J Hyndman

Bayesian Robust Multivariate Time Series Analysis in Nonlinear Regression Models with Vector Autoregressive and t-distributed Errors **(Ref: *8107*)**

Alexander Dorndorf, Prof. Boris Kargoll, Prof. Jens-Anfré Paffenholz and Pd Dr. Hamza Alkhatib

(13:30-14:30) Plenary Talk:
Prof. Eamonn Keogh

Distinguished Professor, Department of Computer Science and Engineering University of California Riverside

Title of the presentation: Irrational Exuberance: Has Deep Learning Contributed Anything to Time Series problems?

VIRTUAL SESSION ITISE - 2023

SESSIONS B and C

Wednesday, July 12, 2023

(9:00-10:15) Session B.1: Advanced Econometric Methods for Economic Analysis and Finance

Chairman: Dr. Charalampos Agiropoulos

Importancia del sector agrícola en la economía ecuatoriana. (**Ref:** *2590*)

Victor Xavier Quinde Rosales, Rina Mercedes Bucaram Leverone and Luis Enrique Mejia Cervantes

Unconventional Monetary Policy in India: Impact on Financial Markets (**Ref:** *3377*)

Pami Dua and Divya Tuteja

On time-dependent cointegration with two examples (**Ref:** *6012*)

Guy Mélard

Energy sector and stock market nexus: a dynamic PCA and wavelet-based mixed approach (**Ref:** *8519*)

Marco Tedeschi and Paolo Canofari

(9:00-11:00) Session C.1: Data Preprocessing Methods in Time Series

Chairman: Dr. Alberto Guillen

Integrating seasonal adjustment approaches of official surveys on labour supply and demand (**Ref:** *738*)

Cinzia Graziani, Annalisa Lucarelli, Maurizio Lucarelli, Emilia Matera and Andrea Spizzichino

Role of Environmental Factors in Forming Birth Time Series (**Ref:** *3148*)

Arzu Sardarli, Frank Trovato and Andrei Volodin

Forecasting of signals by forecasting linear recurrence relations (**Ref:** *3535*)

Nina Golyandina and Egor Shapoval

Geodynamic Modeling in Central America Based on GNSS Time Series Analysis. Special Case: The Nicoya Earthquake (Costa Rica, 2012) (**Ref:** *4779*)

Paola Barba Ceballos, Nely Pérez-Méndez, Javier Ramirez, Belén Rosado, Vanessa Jiménez Morales and Manuel Berrocoso

Analysis of GNSS time series recorded on South Shetland Island and Antarctic Peninsula during the geodynamic activity in 2019 of the underwater volcano ORCA (Brandfield Sea Rift, Antarctica). (**Ref:** *8056*)

Belén Rosado, Paola Barba Ceballos, Javier Ramirez, Enrique Carmona, Rosa Martín León, Vanessa Jiménez Morales, Jorge Gárate, Amos de Gil and Manuel Berrocoso

A New Asymmetric GARCH Model: Testing, Estimation and an Application to Falling and Rising Markets (**Ref:** *8080*)

Abdulnasser Hatemi-J

Tropospheric and Ionoferic Modeling Using GNSS Time Series In Volcanic Eruptions (La Palma, 2021) (**Ref:** *9354*)

Paola Barba Ceballos, Javier Ramírez Zelaya, Vanessa Jiménez Morales, Belén Rosado Moscoso and Manuel Berrocoso Domínguez

Treatment and analysis of multiparametric time series from a seismogeodetic system for monitoring tectonic activity in the Gulf of Cádiz. (**Ref:** *9691*)

Javier Ramírez-Zelaya, Vanessa Jiménez Morales, Paola Barba, Belén Rosado, Jorge Garate and Manuel Berrocoso

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(10:15-11:15) Session B.2: Real Macroeconomic Monitoring and Forecasting

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Chairman: Dr. Agustin Indaco

Impact of Recent Crises on Inter-linkages across International Currencies (**Ref:** *1534*)

Shipra Bhatia and Dr Divya Tuteja

It can't get no worse: Using Twitter data to improve GDP estimates for developing countries (**Ref:** *2204*)

Agustin Indaco

Data Mining Application for Empowering Demoethical Model (**Ref:** *5794*)

Rinat Zhanbayev, Anna V Shutaleva, Muhhamad Irfan and Daniil G Maksimov

Changes in growth volatility in MERCOSUR countries: is there evidence of decoupling of the Uruguayan economy? (**Ref:** *6165*)

Bibiana Lanzilotta, Gonzalo Zunino and Rafael Mosteiro

(11:40-12:55) Session B.3: Energy Forecasting

Chairman: Dr. Eduardo Caro and Dr. Neta Rabin

Combination of Probabilistic Predictions for Wind Energy Production (**Ref:** *4095*)

Shadi Nouhitehrani, Jesús Juan and Eduardo Caro

Meteorology Effects over the Spanish Insular Electricity Consumption (**Ref:** *4324*)

Eduardo Caro Huertas and Jesús Juan Ruiz

Approximation of Weymouth Equation using Mathematical Programs
with Complementarity Constraints for Natural Gas Transportation (**Ref:** *8945*)

*Cristian Blanco-Martínez, David Augusto Cardenas-Peña, Mauricio
Holguín-Londoño, Andrés Marino Álvarez-Meza and Alvaro Angel
Orozco-Gutiérrez*

Multi-Output Variational Gaussian Process for Daily Forecasting of
Hydrological Resources (**Ref:** *9671*)

*Julián Pastrana, David Cárdenas, Mauricio Holguín, Germán
Castellanos and Álvaro Orozco*

A forecasting model for the prediction of system imbalance in the Greek
power system (**Ref:** *2049*)

*Konstantinos Plakas, Nikos Andriopoulos, Alexios Birbas, Ioannis
Moraitis and Alex Papalexopoulos*

(11:40-15:00) Session C.2: Econometric Models and Forecasting (Short Presentation)

Chairman: Dr. Francesco Montaruli

Structural shocks and trend inflation (**Ref:** *396*)

Ivan Mendieta-Munoz and Bowen Fu

Estimation and Prediction of Slowly Time-Varying Parameters in
GARCH models: A Non-parametric Approach (**Ref:** *909*)

*Jorge Muñoz Mendoza, Guillermo Ferreira Cabezas, Jorge Arratia
Llancao, Francisco Rodríguez Cortés, Miguel Flores Sánchez and Jorge
Mateu*

The effect analysis of price elasticity on the forcast of agricultural
determinants using the Nerlove model (**Ref:** *2485*)

*Okou Guei Cyrille, Kole Keita, N'Dri Yao Aubin and Kouakou K.
Auguste*

Conceptual Model of Satisfaction with Municipal Hygiene Case Study:
City of Rijeka (**Ref:** *2918*)

   Drago Pupavac, Marija Ivaniš and Renee Škulić

Forecasting oil price with Bayesian dynamic finite mixture models (**Ref:** *3012*)

   Krzysztof Drachal

Combine to compete: improving fiscal forecast accuracy over time (**Ref:** *3073*)

   Peter Claeys

Profiting from the Russian-Ukrainian War - Social Responsible
Investment in the Context of Geoeconomics and Geopolitical Risk (**Ref:** *3400*)

   Lucia Morales and Daniel Rajmil

Using the Cramér-von Mises test statistic to examine the effectiveness of
cryptocurrencies (**Ref:** *6636*)

   Aktham Maghyereh and Mohammad Al Shboul

Effect of Real Exchange Rate on Per Capita Real Gross Domestic Product
in Pakistan: A Time Series Analysis (**Ref:** *7079*)

   Sakina Bibi and Khadija Shams

Classical Hurst Exponent Vs. Dynamic Hurst : A Study of The Impact on
Subprime and Covid-19 Crises on the Efficient African Stock Exchanges (**Ref:** *7230*)

   Oumou Kalsoum Diallo and Pierre Mendy

Dynamic Modeling and Forecasting: A Robust Approach based on the
Rules Governing the Dynamic Behavior (**Ref:** *7804*)

   Muhammad Ashfaq Ahmed and Nasreen Nawaz

Are traditional cointegration models intrinsically misspecified? The Case
of Equipment Investment in the U.S. (**Ref:** *1022*)

   Mustafa İsmihan, Mustafa Can Küçüker and Fatma Muazzez Utku
   İsmihan

Stock, Exchange and Commodity Markets Linkages: Implication for Risk
Diversification and Portfolio Management (**Ref:** *8110*)

   Jorge Muñoz Mendoza, Carmen Veloso Ramos, Carlos Delgado
   Fuentealba, Edinson Cornejo Saavedra, Sandra Sepúlveda Yelpo and
   Diego Gómez Melo

Nowcasting Regional Economic Activity in Italy During the Pandemics (**Ref:** *8268*)

   Francesco Montaruli and Valter Di Giacinto

Connectedness in the Global Banking Market Network: Implications for
Risk Management and Financial Policy (**Ref: *8115***)

*Jorge Muñoz Mendoza, Carmen Veloso Ramos, Carlos Delgado
Fuentealba, Iván Araya Gómez, Sandra Sepúlveda Yelpo and Edinson
Cornejo Saavedra*

The impact of national minimum wage policy on inflation and
unemployment in South Africa: A segmented regression analysis (**Ref: *9731***)

Marvellous Ngundu, Zitsile Khumalo and Santos Bila

(16:00-17:45) Session B.4: Econometric Models

Chairman: Dr. Alberto Guillen

Forecasting Tangency Portfolios and Investing in the Minimum Euclidean
Distance Portfolio to Maximize Out-of-Sample Sharpe Ratios (**Ref: *4210***)

Nolan Alexander and William Scherer

Generalization in the resolution of the VAR model in the dynamics of
systems of simultaneous equations in differences (**Ref: *5185***)

Gerardo Covarrubias and Xuedong Liu

Sustainable Development of Renewable Energy Consumption in G7 and
ASEAN-5 Countries: Panel Fixed Effect Econometric Modelling (**Ref: *6277***)

Aye Aye Khin, Kui Ming Tiong, Whee Yen Wong and Sijess Hong

GDP, employment, and wages in Colombia. The challenge of creating
more and better jobs (**Ref: *7827***)

Pablo Adrian Garlati-Bertoldi

Importance of the agricultural sector in the Ecuadorian economy (**Ref: *7970***)

*Victor Xavier Quinde Rosales, Rina Mercedes Bucaram Leverone and
Luis Enrique Mejia Cervantes*

Sustainable Investments and Investor-Surplus During Crisis (**Ref: *8195***)

Xiang Lin and Ranjula Bali Swain

The Dutch Disease in Angola: An Empirical Analysis (**Ref: *9674***)

Zsuzsanna Biedermann, Tamás Barczikay and László Szalai

(16:00-17:45) Session C.3: Time Series Analysis with Computational Intelligence

Chairman: Dr. Arzu Sardarli

Childcare Price Trajectories in the United States from 2008 to2018:
Evidence from the National Database of Childcare Prices (**Ref:** *1683*)

  Giorleny Altamirano Rayo and Liana Christin Landívar

Offshore Wind Power Forecasting Based on WPD and optimized deep
learning methods (**Ref:** *3505*)

  *Shahram Hanifi, Saeid Lotfian, Hossein Zare-Behtash and Andrea
  Cammarano*

An Auto Encoder and Generative Adversarial Network Model for Time
Series Data Classification (**Ref:** *3755*)

  Junpeng Bao, Zihang Liu, Junqing Wang and Yanhua Li

Machine Learning Approach to analyze the relation of Financial
Performance and Sports Performance in Football Clubs (**Ref:** *4209*)

  Gianmarco Candura, Emilia Fares, Giovanni Masala and Filippo Petroni

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**(17:40-20:40) Session B.5: Time Series Analysis with
Computational Intelligence (Short Presentation)**

  Chairman: Dr. Javier Oliver Muncharaz

A Machine Learning Approach For Bitcoin Forecasting (**Ref:** *420*)

  Stefano Sossi-Rojas, Gissel Velarde and Damian Zieba

Machine Learning for Multivariate Time Series with the R Package mlmts (**Ref:** *808*)

  Ángel López-Oriona

Evaluation of Heuristics for Taken's Theorem Hyper-Parameters
Optimization in Regression Tasks (**Ref:** *2032*)

  Rodrigo Hernández-Mazariegos, Jesus Ortiz-Bejar and Jose Ortiz-Bejar

A Simulation Package in VBA to Support Finance Students for
Constructing Optimal Portfolios (**Ref:** *2580*)

  Abdulnasser Hatemi-J and Alan Mustafa

How closely do Australian banks interconnected? (**Ref:** *2767*)

  Gia Huynh, Fennee Chong and Bharanidharan Shanmugam

Hints of Earlier and Other Creation: Unsupervised Machine Learning in
Financial Time-Series Analysis (**Ref:** *2965*)

  James Chen and Charalampos Agiropoulos

BERT for Solar Irradiance Time Series Imputation (**Ref: *3116***)

Llinet Benavides Cesar, Miguel Ángel Manso Callejo and Calimanut-Ionut Cira

Optimizing the Spatial-Temporal Extent of Environmental Factors in Forecasting El Niño and La Niña Using Recurrent Neural Network (**Ref: *3396***)

Jahnavi Jonnalagadda and Mahdi Hashemi

Quality Aware Conditional Generative Adversarial Networks for Precipitation Nowcasting (**Ref: *3500***)

Jahnavi Jonnalagadda and Mahdi Hashemi

Multivariable NARX based Neural Networks Models for Short-term Water Level Forecasting (**Ref: *3744***)

Jackson Renteria-Mena, Douglas Plaza and Eduardo Giraldo

Slope Entropy Characterisation: Adding another interval parameter to the original method (**Ref: *6374***)

Mahdy Kouka and David Cuesta-Frau

(17:40-20:40) Session C.4: Applications in: Energy, Finance, Networks, etc (Part I)

Chairman: Dr. Hector Pomares

A General Interest Policy-oriented Reading of the GDPR to Fill its Data Sharing Gaps for Research (**Ref: *322***)

Giulia Schneider and Giovanni Comandè

Analysis of earthquake dynamics by methods of fractal geometry (**Ref: *1042***)

Danila Komlev and Valeria Shikheeva

Green Deal Goals versus Financial Performance: the Case of Euro Stoxx 50 Companies (**Ref: *2119***)

Raminta Vaitiekuniene

Demographic forecasting as a driver to rethink urban sustainability in the African context. (**Ref: *3418***)

Dr. Carlo Alberini

The Inner Struggles of Transitioning to Democracy and Democratic Consolidation in Sudan (**Ref: *3720***)

Andrew Tchie

Review and potentials of tourist management in the fourth industrial revolution (**Ref:** *4313*)

> *Enrique García-García, Diqian Ren, Sergio Gallego-García and Manuel García-García*

Hierarchical Multiple Regression and Principal Component Analysis for Investigating the Driver Behavior in Kuwait toward Willingness to Give Way to Emergency Medical Service (EMS) Vehicles (**Ref:** *5326*)

> *Sharaf Alkheder*

Between Crises and Opportunities: Identifying Patterns in the Flow of Passengers and Tourists in Brazil Between 1993 and 2021 (**Ref:** *5876*)

> *Socrates Jacobo Moquete Guzmán and Roque Pinto*

Intelligent models for friction failures forecasting using acoustic time series: challenges, current status and future prospective (**Ref:** *5936*)

> *Sergey Shevchik, Vigneashwara Solairajapandiyan, Toni Ivas, Giulio Masinelli, Kilian Wasmer and Patrik Hoffmann*

Short-term Polar Motion Forecast Based on the Holt-Winters Additive Algorithm and Angular Momenta of Global Surficial Geophysical Fluids (**Ref:** *6251*)

> *Jiesi Luo, Zihan Pan and Wei Chen*

Impact of Dynamic Closure Gates on storm surge levels in Barnegat Bay, NJ during Hurricane Sandy. (**Ref:** *6440*)

> *Gregory Slusarczyk, Mary A. Cialone and Robert Hampson*

Thursday, July 13th, 2023

(9:00-11:00) Session B.6: Econometric Forecasting

Chairman: Dr. Martín Solís

A CNN-BiLSTM architecture for macroeconomic time series forecasting (**Ref: *329***)

Alessio Staffini

Econometric modeling of the impact of the COVID19 pandemic on the volatility of the financial markets (**Ref: *5035***)

Abdessamad Ouchen

Assessing the Effect of Co-production on Education Quality (**Ref: *7489***)

Hanane Azemzi and El Houssaine Erraoui

Times Series Regression Modelling: replication, estimation and aggregation through maximum entropy (**Ref: *7770***)

Jorge Duarte, Maria Costa and Pedro Macedo

A proposal of Transfer Learning for monthly macro-economic time series forecast. (**Ref: *8688***)

Martín Solís and Luis-Alexander Calvo-Valverde

Foreing Exchange forecasting models: ARIMA and LSTM comparison (**Ref: *8802***)

Fernando García, Francisco Guijarro, Javier Oliver and Rima Tamošiūnienė

Modeling of leishmaniasis infection dynamics: A comparative time series analysis with VAR, VECM, Generalized Linear and Markov Switching models (**Ref: *9422***)

Fadoua Badaoui, Souad Bouhout, Amine Amar and Kenza Khomsi

Performance of Negatively Screened Sustainable Investments during the COVID-19 (**Ref: *5852***)

Xiang Lin and Ranjula Bali Swain

(9:00-11:00) Session C.5: Applications in: Energy, Finance, Networks, Meteorology, Health, etc (Part II)

Chairman: Dr. Shanthi Saubhagya

Statistical Analysis and Modeling the Dissipation of Volatile Organic Compounds from Industrial Emissions (**Ref:** *3363*)

   Sebastian-Barbu Barbes, Alina Bărbulescu and Lucica Barbes

Predicting Safety- Critical Events in Traffic Flow Based on Time-Series (**Ref:** *2003*)

   Jamal Raiyn and Amgad Seif

Metaheuristic-based forecasting approach for planning and dimensioning 5G and beyond Telecommunication Networks (**Ref:** *6062*)

   Mohamed Ouwais Kabaou, Nesrine Zoghlami and Mohamed Fayech

Analyzing the Business Cycle Properties and Its Relationship with Electricity Consumption and Temperatures in Mexico (**Ref:** *6770*)

   Vicente German-Soto and Ruth Bordallo Favela

The Influence of Solar Activity on Snow Cover over the Qinghai–Tibet Plateau and Its Mechanism Analysis (**Ref:** *7250*)

   Yan Song, Zhicai Li, Yaqing Zhou, Xunqiang Bi, Tiangui Xiao and Ziniu Xiao

Bayesian forecasting algebraic algorithm for forecasting non-Gaussian air contaminated material after an accident. (**Ref:** *7413*)

   Ali Gargoum

On the statistical characteristics of dry and rainfall events in northern Tunisia (**Ref:** *8322*)

   Majid Mathlouthi and Fethi Lebdi

Threatening and threatened: How forecasting distribution of species under changing climate helps in biodiversity conservation (**Ref:** *8605*)

   Achyut Kumar Banerjee and Yelin Huang

Modeling of the Dynamic Impacts of the Financial Market, Economic and Trade Policy Uncertainties on Import Demand (**Ref:** *9606*)

   Miao Miao, Jiang Yushi and Dinkneh Gebre Borojo

A review of the potentialities of statistical and mathematical approaches (**Ref:** *9608*)

   Sergio Gallego-García

(11:20-12:10) Session B.7: Health Forecasting

   Chairman: Dr. Wiwik Anggraeni

Social Network Analysis and Polyamory (**Ref:** *2082*)

   Janet Bennion

Calculating Effectiveness of Covid-19 Non-Pharmaceutical Interventions by Interrupted Time Series Analysis with Clustering-based Counterfactual Country (**Ref: *4130***)

Fatemeh Navazi, Yufei Yuan and Norm Archer

Forecasting the Case Number of Infectious Diseases using Type-2 Fuzzy Logic for Diphtheria Case Study (**Ref: *9451***)

Wiwik Anggraeni, Maria Firdausiah and Muhammad Ilham Perdana

(11:20-12:10) Session C.6: Forecasting Performance Evaluation

Chairman: Dr. Fernando Rojas

Analysis of the Application of Different Forecasting Methods for Time Series in the Context of the Aeronautical Industry (**Ref: *2880***)

Antônio Augusto Rodrigues de Camargo and Mauri Aparecido de Oliveira

But... What Is The Poverty Rate Today? Testing Poverty Nowcasting Methods in Latin America and the Caribbean (**Ref: *6167***)

German Caruso, Leonardo Lucchetti, Eduardo Malasquez, Thiago Scot and Andres Castaneda

Probabilistic Forecasts for Solar Irradiance using WRF-Solar Ensemble Prediction System (**Ref: *9282***)

Saurabh Verma and Charu Singh

(12:10-14:00) Session B.8: Advances in Time Series Analysis and Forecasts in Engineering Sciences

Chairman: Dr. Alina Barbulescu

Genetic Algorithm approach of modeling the structural global stiffness (**Ref: *386***)

Radu Panaitescu, Stefan Mocanu, Anca-Ruxandra Sasu and Oana Tonciu

Modeling the Road Accesibility in a Flood-Prone Area, in Romania (**Ref: *3114***)

Cristian Popescu and Alina Barbulescu

Marine Biota and Microplastics Ingestion: a Statistical Approach (**Ref: *5105***)

Andreea Mădălina Ciucă, Elena Stoica and Lucica Barbes

Assessing the climate change on the Tuzla-Nuntasi Basin, Romania (**Ref: *6152***)

Gabriel Dobrica, Carmen Maftei and Alina Barbulescu

Statistical Analysis and Modeling of Pollutants Series in the Region of Brasov, Romania (**Ref:** *3871*)

   Maftei Carmen and Alina Barbulescu

Assessing the water quality effluent from a treatment plant (**Ref:** *4715*)

   Alina Barbulescu, Lucica Barbes and Cristian Stefan Dumitriu

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(12:10-14:00) Session C.7: Artificial Intelligence and Sustainability

   Chairman: Dr. Ebrahim Ghaderpour

Extreme insurance claims prediction model based on Extreme Learning Machine (**Ref:** *213*)

   Yassine Kouach, Abderrahim El Attar and Mostafa El Hachloufi

Using Machine Learning Models to Predict Groundwater Potentiality in a Large Mountainous Region under Semi-Arid Climate (**Ref:** *2350*)

   Mohammed Hssaisoune, Mustapha Namous, Tarik Tagma, Hasna Eloudi and Lhoussaine Bouchaou

Development of methodology for the Evaluation of Solar Energy through hybrid models for the energy sector (**Ref:** *3723*)

   Georgina Lizeth González, Jesus Cerezo and Guillermo Santamaria

Aviation technology evolution and roadmap of Hong Kong (**Ref:** *5526*)

   Pengyu Zhu, Ning Chen, Swathi Akella and Jeffrey Chow

(16:00-17:00) Session B.9: Forecasting performance evaluation

   Chairman: Dr. Ignacio Rojas

Formation of a Forecast of Time Series of Data for the Purposes of Anomaly Detection Using a Digital Signal Processing Unit Connected in Series and an Artificial Neural Network - a Predictive Autoencoder (**Ref:** *4411*)

   Anastasiya Pletenkova and Andrey Ragozin

Inventory improvement in tyre retail through demand forecasting (**Ref:** *4525*)

   Magda Monteiro, Diana Neves and Maria José Felício

On Forecasting of Carbon Allowance Futures Prices and Parametrisation of two-factor model (**Ref:** *5381*)

   Jun Han, Nino Kordzakhia, Pavel Shevchenko, Stefan Trueck and Karol Binkowski

Forecasting the tails of financial indexes distributions (**Ref:** *9270*)

Massimiliano Frezza

(16:00-17:00) Session C.8: : Health Forecasting

Chairman: Dr. Abdourrahmane ATTO and Dr. Juan R. Trapero

Artificial Intelligence-based forecasting models for COVID-19 disease (**Ref:** *464*)

Safa Bahri, Nesrine Zoghlami and Moetez Kdayem

Forecasts of the mortality risk of COVID-19 using the Markov-switching autoregressive model: A case study of Nigeria (**Ref:** *6682*)

Idowu Ayodeji

Evaluation of models for predicting the occurrence of visceral leishmaniasis in 09 Brazilian states, 2001 to 2017: an ecological time series study (**Ref:** *8574*)

Marcos Venicius Malveira de Lima and Gabriel Zorello Laporta

(17:05-20:15) Session B.10: Applications in: Energy, Finance, Transportation, Networks, etc (Short Presentation)

Chairman: Dr. Fernando Rojas

Investigate FIBA World Cup 2019: Evidence using Advanced Statistical Analysis and Quantitative tools (**Ref:** *949*)

Christos Katris

Comparison of Privatization in the Republic of Croatia and Selected Former Communist Countries (**Ref:** *1459*)

Helena Nikolic and Jan Horacek

Automated Approach for Generating and Evaluating Traffic Incident Response Plans (**Ref:** *2014*)

Adel Almohammad and Panos Georgakis

Applications of Tobit Censored Exponential Smoothing to inventory management (**Ref:** *3312*)

Juan R. Trapero, Diego Pedregal and Enrique Holgado

Quadratic Mixed Integer Programming for deleting outliers in time series models (**Ref:** *4420*)

Vassiliki Karioti

Gaining flexibility by rethinking offshore outsourcing for managing complexity and disruption (**Ref:** *4773*)

   Michela Pellicelli

Long Lead ENSO Forecast using Adaptive Graph Convolutional Recurrent Neural Network (**Ref:** *6625*)

   Jahnavi Jonnalagadda and Mahdi Hashemi

Measuring extremal clustering in time series (**Ref:** *7215*)

   Marta Ferreira

Does competition contribute to stability? - empirical evidence from the European Union banking sector (**Ref:** *7259*)

   Candida Ferreira

Impact of the Covid Pandemic on Global Ecotourism : A Critical Analysis (**Ref:** *8577*)

   Kanupriya Kanupriya and Kanupriya Kanupriya

The optimal share of solar energy in an energy island (**Ref:** *8698*)

   Ofira Ayalon, Tsur Moshe and Yaniv Reingewertz

An Application of Ensemble Spatiotemporal Data Mining Techniques for Rainfall Forecasting (**Ref:** *8707*)

   Shanthi Saubhagya, Chandima Tilakaratne, Musa Mammadov and Pemantha Lakraj

Clustering of time series based on forecasting performance of global models (**Ref:** *8929*)

   Ángel López-Oriona

Methods and Scenario Analysis into Regional Area Participatory Planning of Sustainable Development. The "Roses Valley" Sothern Morocco, a Case Study (**Ref:** *9062*)

   Tiziana Vitolo, Antonio Bertini and Immacolata Caruso

Leveraging Temporal Patterns in Forecasting (**Ref:** *6527*)

   Thomas Schincariol, Thomas Chadefaux and Hannah Frank

(17:05-20:15) Session C.9: New Advances in Time Series Analysis and Forecasting (Part II) (Short Presentation)

Chairman: Dr. Nicolas Beldiceanu

Contribution of Indirect Taxes on Goods to Economic Growth of Pakistan (1972-2018) (**Ref:** *481*)

   Wajahat Rehman and Raza Ali Khan

Improving Data Assimilation for Satellite Data in Hydrodynamic Modeling (**Ref:** *2387*)
  Taha Aawar

Automata Based Multivariate Time Series Analysis for Anomaly
Detection over Sliding Time Windows (**Ref:** *3787*)
  Arnold Hien, Nicolas Beldiceanu, Claude-Guy Quimper and
  Maria-Isabel Restrepo

Urban Heat Island Intensity Prediction in the Context of Heat Waves: An
Evaluation of Model Performance (**Ref:** *4024*)
  Aner Martinez-Soto and Alexander Zipf

Can LSTM outperform volatility-econometric models? (**Ref:** *5311*)
  German Rodikov and Nino Antulov-Fantulin

Sentiment analysis based on multifractal methods (**Ref:** *1531*)
  Mariia Chuprina and Valeriya Shikheyeva

Friday, July 14th, 2023

(8:45-10:15) Session B.11: Forecasting Financial Markets

Chairman: Dr. Amine Amar and Dr. Aleksandra Wójcicka-Wójtowicz

Comparative analysis of recommendations issued by stockbrokers and oriented fuzzy numbers in case of DAX companies (**Ref:** *4131*)

Aleksandra Wójcicka-Wójtowicz and Anna Łyczkowska-Hanćkowiak

Financial Time Series Models - Comprehensive Review of Deep Learning Approaches and Practical Recommendations (**Ref:** *5498*)

Mateusz Buczynski, Marcin Chlebus, Katarzyna Kopczewska and Marcin Zajenkowski

Forecasting Pakistan's GDP Growth with Leading Indicators: A MIDAS Approach (**Ref:** *6543*)

Tanweer Islam and Sidra Tahir

Enhancement of consumption forecasting by customers' behavioral predictability segregation (**Ref:** *8226*)

Maria Koshkareva and Anton Kovantsev

Hyperautomation in Supershop using Machine Learning (**Ref:** *8733*)

Shuvro Ahmed, Joy Karmoker, Md. Mahamudur Rahman, Rajesh Mojumder, Shadman Fatin, Dr. Md. Golam Rabiul Alam and Tanzim Reza

Modeling contagion of financial markets: A GARCH-EVT Copula approach (**Ref:** *9798*)

Gueï Cyrille Okou and Amine Amar

(10:15- 11:45) Session B.12: New Advances in Time Series Analysis and Forecasting

Chairman: Dr. Yuvraj Sunecher and Dr.Christos Katris

A Novel Unconstrained Geometric BINAR(1) Model. (**Ref:** *3892*)

Yuvraj Sunecher and Naushad Mamode Khan

Adaptive Mahalanobis kernel for gaussian kernel adaptive filters (**Ref:** *4467*)

Juan David Hernández-Sánchez, David Augusto Cárdenas-Peña and Álvaro Ángel Orozco-Gutiérrez

Musical aptitude screening: a Brazilian experience un-der construction (**Ref:** *5135*)

Fabiana Oliveira Koga, Rosemeire de Araújo Rangni and Rafael Pereira

Supervised Classification of Spatio-Temporal Change Detection Maps (**Ref:** *3582*)

Maia de Souza Ugarte, Matthieu Gallet, Abdourrahmane Atto and Aluísio de Souza Pinheiro

Adaptive bandwidth based on maximum variance of information potential for Gaussian kernel adaptive filters (**Ref:** *8310*)

Juan David Hernández-Sánchez, Álvaro Ángel Orozco Gutiérrez and David Augusto Cárdenas-Peña

Addressing the multiple dimensions of poverty: Dimensionality Reduction with t-Distributed Stochastic Neighbor Embedding (tSNE) Algorithm (**Ref:** *8677*)

Amine Amar

(12:00-12:55) Session B.13: Deep Learning Methods in Time Series

Chairman: Dr. Grzegorz Dudek

Influencers, Twitter and Bitcoin's volatility: an analysis based on transfer entropy and deep learning (**Ref:** *1302*)

Diana Mendes, Jana Lage, Fernando Batista, Vivaldo Mendes and Nuno Ferreira

Dynamic Tikhonov State Forecasting based on Large-Scale Deep Neural Networks Constraints (**Ref:** *1995*)

Cristhian Daniel Molina-Machado, Juan David Martinez-Vargas and Eduardo Giraldo

Combining Forecasts of Time Series with Complex Seasonality using LSTM-based Meta-Learning (**Ref:** *4046*)

Grzegorz Dudek

Abstracts book ITISE-2023

[102] *Automating the work of the planners in reaching a consensus forecast in the sales & operations planning (S&OP) process*

Gabriel David Pinto (Azrieli - College of Engineering Jerusalem) and Roei Aviram (Inteli-chain).

Companies who survived the volatility of their supply and demand of the last years likely did so by selling through inventory and focusing on their working capital. Suppliers and manufacturers from all over the world have largely been put to the test, fulfillment delays, massive stock shortages, and lengthy backorders on their popular inventory items. Companies need to address these inefficiencies by seeking to work smarter, not harder. Without fail, one of the best ways to improve inefficiency in the supply chain is by improving forecasting through automations. Intelichain Labs is a fast-growing global supply chain startup which provide a cloud-based solution of a leading-practice Sales & Operations Planning (S&OP). The demand management system we developed has: (1) Advanced segmentation capabilities including 9 Box (ABC and XYZ), (2) optimal hierarchy management, (3) key performance indicators (KPI's), and (4) Artificial intelligence (AI) and machine learning (ML) capabilities that represents an accurate consensus forecast. The system examines about 30 statistical models (mainly time-series) and the lowest error is the statistical model. We transform real time data into insights and into business recommendations using advanced visualization capabilities. Our goal is to help organizations build an intelligent and transparent business planning that would optimize customer responsiveness and dramatically cut down operational costs to support a sustainable growth.

[156] *Prediction of dropping out of academic studies after the first semester of the first year*

Ron Weitzman (Azrieli - College of Engineering Jerusalem) and Gabriel David Pinto (Azrieli - College of Engineering Jerusalem).

The impact of student retention on economic growth and reputation is crucial for higher educational institutions around the world. Many higher education studies have been done over the years regarding student dropout causes and student retention improvement. The dimension of time regarding the phenomenon of dropout from academic studies is critical. Identifying the potential dropout students at the beginning of their studies will allow the institution to take the necessary actions, thus increasing the chances of the students to complete their studies successfully. The novelty of our research is that we offer a model that predicts academic dropouts after the first semester of the first year. Using student data collected from the Azrieli College of Engineering in Jerusalem, we have built a data mining prediction model of college

dropout. Based on the findings of our prediction model, student dropout is highly linked to first semester studies, specifically the first semester average, Calculus I grade, debt incurred by the student, as well as the number of visits to the institution's website during the semester. Using these results as well as additional relevant findings, institutions can support potential dropout students and reduce their rates.

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[213] *Extreme insurance claims prediction model based on Extreme Learning Machine*

Yassine Kouach (Hassan II university), Abderrahim El Attar (Hassan II university) and Mostafa El Hachloufi (Hassan II university).

Industrial development, technical progress, or climate change are accompanied by large-scale risks such as fires, cyberattacks, or climatic disasters. To deal with these severe risks, insurers must be able to offer insurance products adapted to the profiles of the insured and to each class of risk. However, the pricing of extreme risks is difficult given the rareness of events and the low volume of data. With this in mind, the modeling of grave claims is of major importance in a more competitive market. Indeed, adequate pricing of extreme risks makes it possible to offer more competitive rates at the same time without weighing heavily on the claims burden of insurance companies. In this regard, this work seeks to build a pure premium pricing model for extreme claims using artificial intelligence in order to offer fair prices. We are trying to exploit the capacity of artificial intelligence tools as a substitute for the traditional methods already proposed in the context of analysing extreme claims. For this, we first proceed to the analysis of extreme values. According to the theory of extreme values, a claim can be qualified as "severe" if it exceeds a chosen threshold. We aim through this article to use unsupervised statistical learning methods in the determination of the extreme claim threshold. The chosen threshold must make it possible to isolate the extreme claims while simultaneously keeping a sufficient number of claims. Then, we try to estimate the cost of grave claims using artificial intelligence methods. Thus, we propose a pricing model for the extreme pure premium based on the Extreme Learning Machine algorithm. In order to ensure the performance of the Extreme Learning Machine algorithm, we compare the performance of this model with conventional models such as generalized linear models GLM and supervised learning models, namely the decision tree. To apply the algorithms, we will work with open-source fire data. The results of this study show the benefit of pricing extreme claims by Extreme Learning Machine instead of just using traditional methods. The use of the Extreme Learning Machine algorithm allows offering fair value prices according to the degree of risk supported. The implications of this study contribute to actuarial science, in particular pricing issues. The application of this model can be tested in the pricing of severe claims of other insurance branches such as catastrophic risks.

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[290] *Study on the probability of occurrence of wind energy generation given the wind speed: An Analysis Via Theo-ry of Copulas*

Tuany Esthefany Barcellos de Carvalho Silva Tuany (Pontifical Catholic University of Rio de Janeiro), Reinaldo Castro Souza Reinaldo (Pontifical Catholic University of Rio de Janeiro) and Marco Aurélio Sanfins Marco Aurélio (Federal Fluminense University).

This study has wind energy as its central axis; the use of such energy eliminates unwanted waste that harms health and the environment. This work analyzes the dependency relationship between wind speed and wind energy generation; the copula theory was used as a methodological tool. The study is based on the anal-ysis and modeling of the dependence between wind speed data and wind energy generation, for an hourly database of a wind farm in the state of Bahia, Brazil, collected in June 2017. Once the copula, referring to the dependency structure was found, a scenario was simulated presenting the fit of the model as well as the probabilities of occurrence of point intervals.

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[295] *The time-frequency nexus between energy supply, debt and growth for OECD European Countries*

Roman Mestre (Université de Montpellier, MRE) and Mohamed Awada (Université de Montpellier, MRE).

In this paper, continuous wavelet decompositions are used regarding the notions of coherence and phase to analyze the time-frequency dynamics of the existing relationships between energy supply, public debt, and economic growth for a group of European countries. The objective is to identify both the intensity and the direction of the relationship between each pair of variables over time and across frequencies. The concepts of coherence and phase in wavelets are similar in interpretation to correlation-determination, but their particularities lie in their ability to transcribe statistical information

over time and according to various frequencies. The results of the wavelet analysis are interpreted according to the cycles, the two oil shocks, and the 2008 crisis. This reasoning will make it possible to explain the short, medium, and long-term dynamics of the combination of the variables.

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[322] *A General Interest Policy-oriented Reading of the GDPR to Fill its Data Sharing Gaps for Research*

Giulia Schneider (Catholic University of Milan) and Giovanni Comandè (Sant'Anna School of Advanced Studies).

During the pandemic, the European data protection framework for research has been object of many critiques, especially coming from the scientific community. These critiques regard the regulatory uncertainties left open by the GDPR as an impairment to the processing of data for research purposes. This contribution moves from these concerns and proposes a policy-oriented reading of the GDPR, which shows the paths for fostering innovation and data sharing over personal data. It shows that the GDPR provides significant flexibilities for data protection-sound research activities. It asserts that the GDPR's special framework for research activities entails suggestions for a differentiation of data protection regimes respectively applicable to research activities that pursue public interests ("altruistic research") and those which target commercial interests ("egoistic research") . Our assumption is that, up to now, a research-enabling interpretation of the European data protection framework has not been adequately considered at policy level. As illustrated, this policy gap comes along with substantial losses, leaving, unexpectedly, public institutions- and in particular public research institutions- with greater regulatory hurdles for a legitimate and effective performance of data sharing operations. We claim that this contradicts the very policy of the GDPR entangled in its research exceptions and show how the differential research regimes drawn from the GDPR should and can be incorporated into the design of data sharing models, as the ones proposed under the Data Governance Act.

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[329] *A CNN-BiLSTM architecture for macroeconomic time series forecasting*

Alessio Staffini (Department of Economics and Finance, Catholic University of Milan, Largo Gemelli 1, Milan).

In forecasting socio-economic processes, it is essential to have tools that are highly performing, and which results are as close to reality as possible. Forecasting plays an important role in shaping the decisions of governments and central banks about macroeconomic planning, and it is an essential analytical tool in defining the countries' economic strategies. The most common forecasting methods used in the analysis of macroeconomic processes (linear and generalized linear regression models, autoregressive models, etc.) are based on extrapolation, i.e., extending the trend observed in the past (and present) to the future. However, the presence of non-linearity in the socio-economic systems under uncertainty, as well as the partial observability of the processes, has contributed to make researchers and practitioners consider other forecasting methodologies too. In this paper, we analyze 18 time series of macroeconomic variables, about the economy of the United States of America (the recorded values are from June 1947 to December 2019). We first employ "classic" forecasting techniques (such as ARIMA, ARIMAX and VAR) to obtain benchmark results. We then compare these results with those obtained with our proposed Deep Learning architecture. The model we construct can be defined as "hybrid", since it combines a Convolutional Neural Network (CNN) with a Bidirectional Long Short-Term Memory Network (BiLSTM) backend. The combination of these techniques gave us a model that can, for what concerns minimizing the forecast error, compete with and often improve the results obtained with the more classical econometric techniques. The goal of our work is to highlight how, thanks to the recent advances in computing power, new techniques can be added to the set of tools available to the policymaker for forecasting macroeconomic data.

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[386] *Genetic Algorithm approach of modeling the structural global stiffness*

Radu Panaitescu (Technical University of Civil Engineering of Bucharest), Stefan Mocanu (Technical University of Civil Engineering of Bucharest), Anca-Ruxandra Sasu (Technical University of Civil Engineering of Bucharest) and Oana Tonciu (Technical University of Civil Engineering of Bucharest).

Last decades Artificial Intelligence (AI) has become an essential tool for modeling and forecasting in different research fields. Mechanical Engineering makes no exception because practical problems that classical methods can hardly solve can receive more efficient solutions using AI. This paper proposes another way to solve problems specific to the Mechanical Engineering field using AI algorithms implemented in the Global Optimization Toolbox package in Matlab. Given a support scheme of a structural system, the article aims to determine the maximum stiffness of the system based

on the series of moments variation for a variable dimensional parameter of the support. The series represents the basic input for the Genetic Algorithm aiming to determine the extreme of a specific geometric parameter in mechanical structures, named deflection. Finding the minimum of the global function leads to the optimal searched dimensional parameter.

[396] *Structural shocks and trend inflation*

Ivan Mendieta-Munoz (Department of Economics, University of Utah) and Bowen Fu (CEMFS, Hunan University).

This paper aims at identifying the relevant structural shocks that influence long-run inflation expectations in the USA. We propose an unobserved components with stochastic volatility and structural shocks model that incorporates the main structural determinants of the economy into the estimation of trend inflation. Using a novel efficient Bayesian sampling algorithm, we find that inflation expectations exhibit endogeneity derived from changes in specific structural conditions. The results indicate that trend inflation estimates become relatively more volatile once the structural shocks are incorporated, and that four structural shocks Granger-cause trend inflation: productivity, price mark-up, government policy, and finance.

[420] *A Machine Learning Approach For Bitcoin Forecasting*

Stefano Sossi-Rojas (Universidad Privada Boliviana, Computational Systems Engineering), Gissel Velarde (Universidad Privada Boliviana, Computational Systems Engineering) and Damian Zieba (University of Warsaw, Faculty of Economic Sciences).

Bitcoin is one of the cryptocurrencies that is gaining more popularity in recent years. Previous studies have shown that closing price alone is not enough to forecast stock market series. We introduce a new set of time series and demonstrate that a subset is necessary to improve directional accuracy based on a machine learning ensemble. In our experiments, we study which time series and machine learning algorithms deliver the best results. We found that the most relevant time series that contribute to improving directional accuracy are Open, High and Low, with the largest contribution of Low in combination with an ensemble of Gated Recurrent Unit network and a baseline forecast. The relevance of other Bitcoin-related features that are not price-related is negligible. The proposed method delivers similar performance to the state-of-the-art when observing directional accuracy.

[464] *Artificial Intelligence-based forecasting models for COVID-19 disease*

Safa Bahri (ENIT), Nesrine Zoghlami (ENIT) and Moetez Kdayem (ENISO).

Since December 2019, the catastrophic epidemic of se-vere acute respiratory syndrome - The coronavirus (SARS-CoV-2), also known as COVID-2019, has overwhelmed the whole world and put human health under a serious threat. The world is making incredible efforts to combat the unexpected spread of this deadly disease in terms of infrastructure, finances, data sources, protective equip-ment, life-threatening treatments and many other re-sources. Artificial Intelligence researchers and analysts are focusing to develop mathematical models to analyze this epidemic situation using internationally shared data. Contributing to the well-being of a living society, this ar-ticle proposes the use of Machine-Learning and in-depth learning models to understand its daily exponential be-havior as well as predict the future accessibility of COVID-2019 across nations. Two data-driven forecasting models based on Long Short Term Memory (LSTM) and Light Gra-dient Boosting Machine (LightGBM) regressor were se-lected to expect the number of confirmed cases in the most affected countries in the World : USA, Italy, China, Spain, Iran, and Germany, and for Tunisia. Given large training data, LSTM is capable of well capturing the pat-tern of the dynamic growth of graphs with a minimum Mean Absolute Percentage Error (MAPE) compared to LightGBM. Our LSTM model can perfectly be used by ex-perts as a Medical Decision Support System to forecast the total future COVID-19 cases.

[481] *Contribution of Indirect Taxes on Goods to Economic Growth of Pakistan (1972-2018)*

Wajahat Rehman (Visiting Faculty at Department of Economics, University of Karachi and Institute of Business Administration (IBA)) and Raza Ali Khan (Chairman Department of Economics & Management Science, NED University of Engineering & Technology, Karachi, Pakistan).

Economic growth is influential to the change in indirect taxes imposed by the government on production/consumption of goods. This paper tends to identify the empirical relationship between indirect taxes – i.e. federal sales tax, federal excise duty and customs duty, and economic growth of Pakistan. For this purposes, annual time series data from 1972 to 2018 is used. Objective of the study is to evidence the long-run and short-run relationship of federal sales tax, federal excise duty and customs duty along with economic growth. Augmented Dickey fuller unit root tests are used to check the stationarity of each variable. Johansen Cointegration Test is performed to identify the cointegration among variables. Vector Error Correction Model (VECM) is used to estimate the long-run and short-run relationship among the these variables. The result of the study shows that there are 2 cointegrating equations among variables. GDP Lag5, GDP Lag6, ST Lag1, ST Lag5 and FE Lag4 possess positive impact on economic growth of Pakistan. However, GDP Lag2, FE Lag6 and CD Lag7 possess negative impact on economic growth of Pakistan. However, previous years deviations from long-run equilibrium are corrected in current year at an adjustment speed of 33% and 18% for GDP and ST, respectively. As of published statistical records of 2018, sales tax, federal excise duty and customs duty contribute 65 per cent, 9 per cent and 26 per cent, respectively, to total indirect taxes. This collection structure is required to be rationalized to boost economic growth.

[615] *Learning Local Patterns of Time Series for Anomaly Detection*

Kento Kotera (Corporate R&D Center, Toshiba Corporation), Akihiro Yamaguchi (Corporate R&D Center, Toshiba Corporation) and Ken Ueno (Corporate R&D Center, Toshiba Corporation).

The problem of anomaly detection in time series has recently received much attention, but in most practical applications, labels for normal and anomalous data are not available. Furthermore, reasons for anomalous results often must be determined. In this paper, we propose a new anomaly detection method based on the expectation--maximization algorithm, which learns the probabilistic behavior of local patterns inherent in time series in an unsupervised manner. The proposed method is simple yet enables anomaly detection with accuracy comparable with that of the conventional method. In addition, the representation of local patterns based on probabilistic models provides new insight that can be used to determine reasons for anomaly detection decisions.

[629] *Reduced Order Modeling with Skew-Radial Basis Functions for Time Series Prediction*

Manuchehr Aminian (Department of Mathematics, California State Polytechnic University, Pomona, California) and Michael Kirby (Department of Mathematics, Colorado State University).

See attached

[738] *Integrating seasonal adjustment approaches of official surveys on labour supply and demand*

Cinzia Graziani (Istat), Annalisa Lucarelli (Istat), Maurizio Lucarelli (Istat), Emilia Matera (Istat) and Andrea Spizzichino (Istat).

The quarterly Istat official survey on job vacancies and hours worked (Vela) collects information on hours worked and Short-Time Working Allowance (Cig in Italian). Two main indices on labour input can be derived from this survey: the number of hours worked and hours worked per capita. They are on a fixed-based and can be obtained for each economic activity section as a ratio between the value of the indicator in the reference quarter and the average value of the base year (currently 2015). The number of hours worked is the sum of the hours worked by employees (ordinary and extraordinary). The hours worked per capita are obtained by dividing the total hours worked for the average number of employee positions occupied in the quarter.

Following Eurostat guidelines, the direct approach is advisable when the component series have similar characteristics (Eurostat, 2015). Conversely, in cases where the series characteristics are very different, it is preferable to use an indirect approach, recommended when the seasonally adjusted aggregate also contains component series that show a weak seasonality that is difficult to identify.

The use of one approach or the other, in the case where the series are similar leads to results with negligible discrepancies. Otherwise, when series differ, the discrepancies reflected in the seasonally adjusted aggregate series may be significant: it is often the case that a relevant number of inconsistencies (also known as out-of-range) are observed between the quarter-on-quarter changes in the aggregated activity sectors and those in each of their component sections.

The impact of the Covid emergency, which affected the economic activity section in significantly different ways, showed some limits of the direct approach. For the amount of hours worked the change from the direct to the indirect approach is relatively simple, while the implementation of the indirect approach for per capita hours worked is more complex and is the object of this abstract.

The experience gained in the seasonal adjustment of a per capita variable in the ISTAT Labour Force Survey (LFS) can be very useful. In particular, the indirect seasonal adjustment method adopted is based on the seasonally adjustment of each single series separately (for the numerator as well as for the denominator) and the series can be then re-aggregated according to the detail of interest. For example, the seasonally adjusted (SA) number of hours worked per capita can be obtained as the ratio of SA hours worked to the SA number of employed persons.

The quality of this methodology was assessed using the main criteria defined in the literature. In particular, in the seasonal adjustment phase, the Eurostat guidelines for the definition of models, identification of outliers, use of calendar effects etc., were respected, and in the evaluation phase of the obtained results, checks were made on quality indicators and residual seasonality and the revision analysis has been carried out.

The above method can be applied over a period of thirty quarters of Vela series, disaggregated by the NACE Rev.2 economic activity sections.

The quality of the new seasonally adjusted Vela series can be assessed through a revision analysis taking into account the new Vela series and those produced with the direct approach. Further insights into the quality of the new approach can be made by comparing the new seasonally adjusted indicators with the other ISTAT macroeconomic indicators related to hours worked, namely: the total number of jobs dependent on OROS (Survey of Employment, Wages and Social Security), the industrial production index, the production index in construction and the turnover index in services.

The encouraging results shown so far by the application of the proposed method to the Vela indicator on per capita hours worked, encourage us to carry on in this direction.

REFERENCES [1] Eurostat. 2015. ESS guidelines on seasonal adjustment. Manuals and guidelines. Luxembourg. [2] Tuzi D. at al, "La rilevazione trimestrale Oros su occupazione e Costo del Lavoro: indicatori e metodologie". Collana Metodi Letture Statistiche, ISBN 978-88-458-1973-5, Istat, Roma.

[783] *Online Adaptive Bagging for Multivariate Time Series Forecasting*

Amal Saadallah (TU Dortmund) and Hanna Mykula (TU Dortmund).

Multivariate Time Series (MTS) is composed of multiple time series variables that are interdependent. On the one hand, this data represents an enriched form of information about the application. On the other hand, the number of these variables can increase drastically and might include irrelevant and redundant ones. This may heighten the curse of dimensionality. Therefore, it is necessary to select the most important time series variables carefully. Typical methods for MTS variable selection and forecasting are designed to operate in a static manner in time or space without taking into account the time-evolving nature of MTS data, which may be subject to the concept drift phenomenon. Therefore, we propose to leverage the power of ensemble learning to tackle the task of online adaptive MTS variable selection implicitly by applying bagging on the variables level. The bagged ensemble is also used to forecast the future values of the MTS. The adaptation is performed in an informed manner following concept-drift detection in both MTS variables dependencies and the ensemble performance over time. Extensive empirical validation on several real-world datasets shows that our method achieves excellent or on-par results in comparison to the State-of-the-Art (SoA) approaches as well as several baselines.

[808] *Machine Learning for Multivariate Time Series with the R Package mlmts*

Ángel López-Oriona (Universidade Da Coruña).

Time series data are ubiquitous nowadays. Whereas most of the literature on the topic deals with univariate time series, multivariate time series have typically received much less attention. However, the development of machine learning algorithms for the latter objects has substantially increased in recent years. The R package mlmts attempts to provide a set of widespread data mining techniques for multivariate series. Several functions allowing the execution of clustering, classification or outlier detection methods, among others, are included in the package. mlmts also incorporates a collection of multivariate time series datasets which are often used to analyse the performance of new classification algorithms. The main characteristics of the package are described and its use is illustrated through various examples.

[835] *Uncertainty in Systemic Risks Rankings: Bayesian and Frequentist Analysis*

Elena Goldman (Lubin School of Business, Pace University).

We propose efficient Bayesian Hamiltonian Monte Carlo method for estimation of systemic risk measures, LRMES, SRISK and ΔCoVaR, and apply it for thirty global systemically important banks and for eighteen largest US financial institutions over the period of 2000-2020. The advantage of the Hamiltonian method is an efficient estimation of all parameters jointly in high dimensional models and providing posterior distributions incorporating parameter uncertainty. The systemic risk measures are computed based on the Dynamic Conditional Correlations model with generalized asymmetric volatility. We estimate the systemic risks posterior distributions and two-step maximum likelihood distributions with bootstrap simulations for LRMES. The systemic risk rankings at different quantiles of the distributions vary considerably using bootstrap approach for computation of LRMES and SRISK, and are more stable with Bayesian posterior distributions using a parametric model. A policymaker may choose to rank the firms using some quantile of their systemic risk distributions such as 90, 95, or 99% depending on risk preferences with higher quantiles being more conservative.

[903] *Forecasting System for Inbound Logistics Material Flows at an International Automotive Company*

John Anderson Torres Mosquera (Universidad del Valle), Carlos Julio Vidal Holguín (Universidad del Valle), Alexander Kressner (Duale Hochschule Baden-Württemberg (DHBW)) and Edwin Loaiza Acuna (Universidad del Valle).

This paper analyzes how a robust and dynamic forecasting system was designed and implemented in order to predict material volumes for the inbound logistics network of an international automotive company. The system aims to reduce transportation logistics costs and improve demand capacity planning for freight forwarders. The forecasting horizon is set for 4-month and 12-month ahead in the future. To solve this problem a timeseries modelling approached was carried out by using different timeseries forecasting methods like ARIMA, Neural Networks, Exponential Smoothing, Prophet, Automated Simple Moving Average, Multivariate Time Series and Ensemble Forecast. Additionally, important data preprocessing methods and a robust model selection framework was used in order to train the models and select the best performing one, this is called Forward Chaining Nested Cross Validation with origin recalibration. The system performance was assessed using the Symmetric Mean Absolute Error (SMAPE). The final version of the software can deliver 4-month-ahead forecasts with a SMAPE lower than 10% for 86% of all material flow connections. The system's forecast output is updated on a monthly basis and was integrated into the inbound logistics network system of the company.

[909] *Estimation and Prediction of Slowly Time-Varying Parameters in GARCH models: A Non-parametric Approach*

Jorge Muñoz Mendoza (University of Concepción), Guillermo Ferreira Cabezas (University of Concepción), Jorge Arratia Llancao (University of Concepción), Francisco Rodríguez Cortés (Universidad Nacional de Colombia), Miguel Flores Sánchez (National Polytechnic School) and Jorge Mateu (Universitat Jaume I).

We propose a state-space approach for a non-parametric tv-GARCH model. Using diverse non-parametric techniques, we estimate slowly time-varying curves for the parameters and employ a recursive system based on the Kalman Filter as a methodological framework to obtain forecasts from the model. Through Monte Carlo simulation exercises and the use of real data from the Selective Stock Price Index (IPSA) of the Chilean stock market, we empirically evaluated the predictive capacity of the model compared to the stationary GARCH(1,1) version. Our findings demonstrate that the non-parametric tv-GARCH(1,1) model provides more accurate forecasts than a stationary GARCH(1,1) model. These results have relevant implications for risk management and portfolio diversification strategies.

[949] *Investigate FIBA World Cup 2019: Evidence using Advanced Statistical Analysis and Quantitative tools*

Christos Katris (University of Patras).

The purpose of this study is to investigate quantitatively the tournament of basketball World Cup 2019. At first is identified the performance of the team by considering some inputs and by using Principal Components Analysis (PCA). Then, is identified the contribution of factors (shooting, rebounding, turnover and free-throw factors) to the performance of the teams with the use of mul-tiple regression. Furthermore, is compared in a head-to-head comparison of offense vs. defence in terms of contribution to team performance. Also, are identified other factors which affected the performance again with the use of multivariate regression. Additionally, in order to identify teams which per-formed better than expected, we consider 3 groups of teams and we employ hierarchical k-means clustering. Finally are suggested machine learning models (Decision Trees, Random Forests and Neural Networks) for the prediction of the final position of the teams on the tournament. It follows a procedure to show the superiority of the above methods over the use of power rankings and also for their comparison. This is the first time that such analysis is taking place, teams can benefit from the results, fans can better understand the game and power rankings before tournaments can be enhanced. The analysis can be used in other sport tournaments as well.

[1022] *Are traditional cointegration models intrinsically misspecified? The Case of Equipment Investment in the U.S.*

Mustafa İsmihan (Eastern Mediterranean University), Mustafa Can Küçüker (Atılım University) and Fatma Muazzez Utku İsmihan (MARA, METU).

A thorough investigation of the determinants of private investment suggests that it is crucially important to decompose the related series into permanent and transitory components and model their dual co-movements as suggested by the novel Dual Adjustment approach [İsmihan, M. (2019). The dual adjustment approach with an application to the consumption function. Central Bank Review, Volume 19, Issue 1, March 2019, Pages 1-8]. This study extends this approach by considering the critical role of the specification of dual components and with an application to private sector equipment investment in the U.S. Our results reveal that the lack of long-run relationships may also potentially arise from intrinsic misspecification issues embedded in the traditional cointegration models.

[1041] *Hierarchical Fuzzy Rule-Based Forecasting of Stock Prices using News Sentiment and Topic Detection*

Petr Hajek (University of Pardubice).

Hierarchical fuzzy rule-based systems are attracting considerable interest in the field of complex multivariate tasks. A striking feature of hierarchical fuzzy rule-based systems is their scalability to complex prediction tasks while effectively dealing with the problem of rule explosion and avoiding the curse of dimensionality. Furthermore, it is conceivable to reach a more comprehensible rule base by appropriate design of hierarchical systems than is the case with traditional rule-based systems. To overcome the problem of inherently uncertain stock markets, this study proposes a hierarchical fuzzy rule-based forecasting system exploiting a feature selection method to identify a relevant subset of stock price determinants. To this end, a parallel tree-like Takagi–Sugeno–Kang fuzzy system is used with the inputs represented by a diverse set of technical indicators and news-based sentiment and topic indicators. The proposed forecasting system is validated for the daily stock price data of 40 major US companies for the period 2010-2021. We show that the system can not only accurately predict daily stock prices but that also interpretable hierarchical structures can be automatically constructed to produce the forecasts.

[1042] *Analysis of earthquake dynamics by methods of fractal geometry*

Danila Komlev (NUST MISIS) and Valeria Shikheeva (NUST MISIS).

Earthquakes are a significant natural hazard that poses a threat to the environment and human life. The analysis of earthquake dynamics is essential for developing effective forecasting strategies and mitigating their destructive consequences. Existing methods, such as the EPA method and the FCAZ algorithmic system, require complex and expensive data acquisition, making them impractical for many applications.

In this study, we propose a novel method for analyzing earthquake dynamics based on fractal geometry. The key advantage of our approach is that it requires only earthquake magnitude data, which are widely available online, making it accessible to a broad range of users.

To analyze the dynamics of earthquakes, we use time series of earthquake magnitudes in different geographic regions. We divide these time series into overlapping intervals, from which we extract the maximum magnitude value. We then construct pseudo-attractors using Takens' embedding theorem and calculate the correlation dimension for each time interval.

We found that significant changes in the correlation dimension were associated with the occurrence of large earthquakes, indicating that our method can provide insights into earthquake dynamics that are not obtainable through other approaches. This finding highlights the novelty of our approach and its potential for advancing earthquake forecasting and mitigation efforts.

Overall, our method offers a significant advantage over existing methods by requiring only earthquake magnitude data, making it more accessible and cost-effective. Our findings suggest that this method has the potential to improve earthquake forecasting and provide new insights into the dynamics of these natural phenomena.

[1045] *Sensor virtualization for anomaly detection of turbo-machinery sensors - An industrial application*

Sachin Shetty (Baker Hughes), Valentina Gori (Baker Hughes) and Giacomo Veneri (Baker Hughes).

We apply a Granger causality and auto-correlation analysis to train a Recurrent Neural Network (RNN) that acts as a Virtual sensor model. These models can be used to check the status of several hundreds of sensors during turbo-machinery units' operation. Checking the health of each sensor is a time-consuming activity. Training a supervised algorithm is not feasible because we don't know all the failure modes that the sensors can undergo. We use a semi-supervised approach and train an RNN (LSTM) on non-anomalous data to build a virtual sensor using other sensors as regressors. We use the Granger causality test to identify the set of input sensors for a given target sensor. We use Auto-correlation Function (ACF) and Partial Auto-correlation Function (PACF) to understand the temporal dependency in data. We then compare the predicted signal vs the real one to raise (in case) an anomaly in real time.

[1048] *The relationship between work engagement and demographic characteristics in the automotive industry*

Pieter Smit (Presenter), Cecile Schultz (Presenter) and Lize Van Hoek (Presenter).

The South African automotive industry is plagued with numerous competitiveness challenges with fair employee remuneration and upskilling of black employees a critical element as part of the automotive industry 2035 vision (Barnes & Black, 2017). In 2013 which was declared the 'Year of the Artisan', the South African government committed to promote artisan development. This commitment was followed by a 10-year focus plan. Through the campaign the aim was to increase this figure annually by 1000 to reach a production of 30,000 artisans per year by 2030 as outlined in the country's National Development Plan. Employees' psychological connection with their work has gained critical importance in the information/service economy of the twenty-first century. In the contemporary world of work, and to compete effectively, companies should not only recruit the top talent, but should also inspire and enable employees to apply their full capabilities. The main purpose of this research was to determine the relationship between demographics characteristics and work engagement in the automotive industry. A survey research design and a quantitative descriptive research approach applying statistical methods will focus on descriptive research to provide a complete and accurate description of the situation. It was clear that there were no significant relationships between work engagement and gender, age, race, field of service and employment status. There was however significant relationships between work engagement and length of service. Organisations must develop policies and motivational procedures to engage their artisans to perform tasks more efficiently and effectively. The engagement of artisans should be improved through selection processes and job design.

[1124] *Air Quality Early Warning System for Delhi: wintertime meteorology and particulate matter (PM2.5 and PM10)*

Prafull Yadav (Savitribai Phule Pune University, Indian Institute of Tropical Meteorology), Aditya Sengupta (National Institute of Technology Rourkela), Sachin Ghude (Indian Institute of Tropical Meteorology) and Gaurav Govardhan (Indian Institute of Tropical Meteorology).

The Indian Institute of Tropical Meteorology (IITM) in collaboration with the National Center for Atmospheric Research (NCAR), has created a high-resolution (400 m) Air Quality Early Warning System (AQEWS) for Delhi. This system incorporates the Three-Dimensional Variational (3DVAR) Data Assimilation, assimilating real-time space-born and in-situ aerosol observations, and producing a 72-hour forecast each day. In this study, we have examined the wintertime meteorology and particulate matter forecast of AQEWS against in-situ observations using various performance statistics during winter 2020-21. Forecasted downwelling shortwave radiation (SWDOWN) and air temperature at 2 meter (T2) showed good agreement with observational data, but with the positive bias of 34 Wm−2 and 3K, respectively, during afternoon hours. The magnitude of forecasted wind speed showed quite a matching trend with observations, but wind direction showed more south-westerly variations as compared to observations. Moderate prediction of Planetary Boundary Layer Height (PBLH) is observed. In three separate Air Quality Index (AQI) categories, the model's air quality forecast is found to be accurate, with critical category events having an accuracy of > 88%. Lower biases (NMSE of 0.09 and MB of 8%) and higher correlations in prediction AQI indicated well model performance.

[1210] *Exploring Hidden Patterns in Macroeconomic Data Series with the Fast Iterative Filtering Algorithm*

Audrey De Dominicis (Università degli Studi di Teramo), Paolo Canofari (Università Politecnica delle Marche), Antonio Cicone (Università degli Studi dell'Aquila), Giovanni Piersanti (Università degli Studi di Teramo) and Mirko Piersanti (Università degli Studi dell'Aquila).

The identification of the time scales related to a stream of macro- economic data is crucial for understanding the dynamic behaviour of an economic system. Standard analysis techniques fail in producing consistently good results due to the non-stationary and non-linear behaviour often observed in financial and economic time series. In this paper, we propose an innovative approach based on the concurring application of a new non-linear data analysis method, Fast Iterative Filtering (FIF), and a multi-scale statistical analysis (Standardized Mean Test). This approach, when applied to typical macroeconomic data series such as the US industrial production index and real GDP, proves to be able to separate automatically time series data into three components: a long-term trend, an intermediate or middle-period behaviour, and a transitory or short-run behaviour. The economic meaning of each component is clearly identified as high-frequency variations due to seasonal behaviour and irregular factors; medium-term fluctuations characterizing business cycle dynamics; a low-frequency trend reflecting the economy's potential growth. All these results make the proposed approach a more performing tool for dissecting macroeconomic time series structure and dynamics and replicating the main features and chronology of the business cycle. The approach is fully data-driven and model-free, being empirical, very local in time and self- adaptive to the nature of the signal, without requiring any predetermined basis functions to be used in data processing and interpretation.

[1302] *Influencers, Twitter and Bitcoin's volatility: an analysis based on transfer entropy and deep learning*

Diana Mendes (Iscte-IUL), Jana Lage (Iscte-IUL), Fernando Batista (Iscte-IUL), Vivaldo Mendes (Iscte-IUL) and Nuno Ferreira (Iscte-IUL).

Like any other cryptocurrency, the Bitcoin price is subject to fluctuations due to several factors, such as macroeconomic and fundamental variables and the sentiment based on public opinion, social networks, and news. Twitter is an essential source of information and value extraction since it is possible to find news in real-time, follow consequences and repercussions, notice what financial market experts are commenting on, and even decide based on influencers' opinions whether to invest or not. This paper explores the causal relationship between the sentiment extracted from the tweets of a group of influencers and the impact exerted on Bitcoin volatility. A selection of influencers from the "crypto world" was made, and through the Twitter API, it was possible to select the tweets of the object of study. The classification model for sentiment analysis is based on FinBERT (Financial Bidirectional Encoder Representations from Transformers), recently developed by Google and focused on unstructured financial data. FinBERT brought the possibility to use pre-trained finance-specific language models since NLP requires large amounts of labeled training data and the application of deep learning for data mining. Based on the selected models, we contemplate only positive and negative feelings to calculate the daily series of the Sentiment Score. Finally, the causal relationship between Bitcoin and sentiment was explored using Transfer Entropy and Granger Causality. We obtained encouraging results highlighting that there is a transfer of information from Sentiment to Returns (and contrary, depending on bad or good news effects) and that it is possible for an influencer to contribute to Bitcoin's volatility.

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[1325] *Efficient Forecasting of Large Scale Hierarchical Time Series via Multilevel Clustering*

Xing Han (University of Texas at Austin), Tongzheng Ren (University of Texas at Austin), Jing Hu (Intuit), Joydeep Ghosh (University of Texas at Austin) and Nhat Ho (University of Texas at Austin).

We propose a novel approach to cluster hierarchical time series (HTS) for efficient forecasting and data analysis. Inspired by a practically important but unstudied problem, we found that leveraging local information when clustering HTS will lead to better performance. The clustering procedure we proposed can cope with massive HTS with arbitrary lengths and structures. In addition to providing better insights, this method can also speed up the forecasting process for a large number of HTS. Each time series is first assigned the forecast from its cluster representative, which can be considered as a ``shrinkage prior'' for the set of time series it represents. Then, the base forecast can be efficiently adjusted to accommodate the specific attributes of the time series. We empirically show that our method substantially improves performance for large-scale clustering and forecasting tasks involving much HTS.

[1363] *Uneven impacts of COVID-19 on residents' utilization of urban parks: A case study of Guangzhou, China*

Li Li (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences), Xiaojian Li (College of Geography and Environment, Henan University), Ning Niu (College of Geography and Environment, Henan University) and Jialin He (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences).

As COVID-19 increased people's dependency on urban parks for physical and psychological well-being, it also has uncertain impacts on park utilization. Understanding these impacts and how the pandemic has contributed to them is an issue that warrants urgent attention. We used multi-source spatio-temporal data to examine urban park use before and during COVID-19 in Guangzhou, China, and constructed a set of regression models to evaluate the associated factors. We found that COVID-19 has significantly reduced the overall utilization of urban parks while also exacerbating spatial unevenness. This was due to residents' limited movement distance, and the diminished role of urban transportation affecting the efficient citywide use of parks. Meanwhile, residents'increased demand for nearby parks amplified the importance of community parks, which exacerbated the consequences caused by the uneven distribution of park resources. We propose that city administrators improve the efficiency of existing parks and prioritize the adequate placement of community parks at urban fringes to improve access. Furthermore, cities with similar layouts as Guangzhou should plan for urban parks from a multiperspective and consider the sub-city level differences to address unevenness during the current pandemic and in the future.

[1364] *Forecasting Day-ahead Expected Shortfall on the EUR/USD Exchange Rate: The (I)relevance of Implied Volatility*

Tomáš Plíhal (Masaryk University), Štefan Lyócsa (Masaryk University) and Tomáš Výrost (Masaryk University).

The existing literature provides mixed results on the usefulness of implied volatility for managing risky assets, while evidence for expected shortfall predictions is almost nonexistent. Given its forward-looking nature, implied volatility might be more valuable than backward-looking measures of realized price fluctuations. Conversely, the volatility risk premium embedded in implied volatility leads to overestimating the observed price variation. This paper explores the benefits of augmenting econometric models used in forecasting the expected shortfall, a risk measured endorsed in the Basel III Accord, with information on implied volatility obtained from EUR/USD option contracts. The day-ahead forecasts are obtained with a two-step procedure, where the estimates of value-at-risk for several quantiles are combined to approximate the predicted expected shortfall. We consider several classes of econometric models: historical simulation, GARCH, quantile regression-based HAR, and combination forecasts. We verify whether the resulting expected shortfall forecasts are well behaved and test the models' accuracy. Our results provide evidence that the information provided by forward-looking implied volatility is more valuable than that in backward-looking realized measures. These results hold across multiple model specifications, are stable over time, hold under alternative loss functions, and are more pronounced during periods of higher market uncertainty when it matters most.

[1368] *Banking sector development and economic growth in developing countries. Does the change in the shadow economy matter? A Nonlinear Panel ARDL*

Khalil Mhadhbi (Faculty of Economic Sciences and Management of Nabeul).

This study revisits the banking sector-economic growth nexus by taking into account the impact of the shadow economy. It uses panel data from 40 developing economies for the period 1991-2017 and applies Panel Non-linear Autoregressive Distributed Lagged (ARDL-PMG) models. By considering cross-sectional dependence tests, it aims to examine the short- and long-run relationship of this nexus. It is perhaps the first research effort that incorporates the role of the shadow economy into the link between banking sector development and economic growth. The findings suggest that negative shadow economy shocks are beneficial for the long-run relationship between banking sector development and economic growth, while the opposite holds true. However, no evidence of these asymmetric results was found, at least in the short run. Furthermore, we find a significant and negative direct impact of the size of the shadow economy on economic growth in both the long and short run. The results of our study suggest important policy recommendations for the governments of developing countries.

[1412] *Improving predictive accuracy in the context of dynamic modeling of non-stationary time series with outliers*

F. Catarina Pereira (University of Minho, Centre of Mathematics, Portugal), A. Manuela Gonçalves (University of Minho, Department of Mathematics and Centre of Mathematics, Portugal) and Marco Costa (University of Aveiro, Centre for Research and Development in Mathematics and Applications, Portugal).

State space models were originally developed in aerospace engineering in the early 1960s for the purpose of monitoring and correcting the trajectory of a spacecraft going to the moon. Today, they have wide applicability in many areas, such as finances \cite{tri21}, ecology \cite{methe21}, machine learning \cite{wu}, and time series analysis and forecasting \cite{mat,monteiro,pereira}. These models associated with the Kalman filter algorithm are a very powerful tool due to their ability to update predictions both in real time and in a recursively procedure as new observation of the time series become available, improving the predictions' accuracy. In addition, state space models are very flexible due to their ability to incorporate fixed effects and stochastic components that can represent the different unobserved components, such as periodic structures, trends, seasonality, and temporal correlation. These components describe the structural variation of the time series under study. Beyond that, potential covariates can be added because they are important for explaining the process and to complement the information introduced by the different stochastic components of the model. These models include two sources of variability, one corresponding to measurement error and the other to process variation. In this way, it becomes simpler to interpret both errors separately. One advantage of these models is that they do not require the assumption of stationarity and can handle time series with missing values in a particularly simple way \cite{mat}. However, in real data the existence of outliers can influence both the parameters' estimation and predictions accuracy. Outliers can be a problem for the model specification and for the accuracy of the predictions since the Kalman filter is not, in general, robust to the presence of outliers. An incorrectly specified model can lead to incorrect covariance matrices of predictions given by the Kalman filter, and thus there is no way to describe the actual quality of the filter \cite{teu}. According to \cite{huang}, the presence of outliers in a time series can induce non-Gaussian heavy-tailed noise, leading to misspecified models, biased estimates, and inaccurate forecasts. \cite{methe} showed that simple linear Gaussian state space models can have estimation problems. Therefore, in this paper, several methods of detecting and treating outliers are discussed. These methods will be compared and illustrated with a simulation study that considers a simple Gaussian stationary state space model with contaminated data with a 5\% contamination percentage. To create the non-stationarity scenario, the local level model, which is a particular case of the state space model, will be considered, for simplicity. Detection and treatment methods' performance is evaluated by the root mean square error (RMSE) and the mean absolute error (MAE) of the Gaussian likelihood parameters' estimates and the one-step ahead predictions of the time series variable. Several scenarios are considered considering different combination of parameters and times series sizes, n, in this case $(n=50,500)$. Time series simulations are generated until 1000 time series have a state space model with valid estimates, that is, estimates within the parameter space.

\bibitem{tri21} Triantafyllopoulos, K.: The State Space Model in Finance. In: Bayesian Inference of State Space Models. Springer Texts in Statistics. Springer, Cham (2021) \url{https://doi.org/10.1007/978-3-030-76124-0_7}

\bibitem{methe21} Auger-Methe, M., Newman, K., Cole, D., Empacher, F., Gryba, R., King, A. A., Leos-Barajas, V., Flemming, J. M., Nielsen, A., Petris, G., Thomas, L.: A guide to state–space modeling of ecological time series. Ecological Monographs, 91, pp. 1--38 (2021) \url{https://doi.org/10.1002/ecm.1470}

\bibitem{wu} Wu, H., Matteson, D., Wells, M.: Interpretable Latent Variables in Deep State Space Models (2022) \url{https://doi.org/10.48550/arxiv.2203.02057}

\bibitem{mat} Matsuura, K.: Time Series Data Analysis with State Space Model. In: Bayesian Statistical Modeling with Stan, R, and Python. Springer, Singapore (2022) \url{https://doi.org/10.1007/978-981-19-4755-1_11}

\bibitem{monteiro} Monteiro, M., Costa, M.: Change Point Detection by State Space Modeling of Long-Term Air Temperature Series in Europe. Stats, 6, pp. 113--130 (2023) \url{https://doi.org/10.3390/stats6010007}

\bibitem{pereira} Pereira, F.C., Gonçalves, A.M., Costa, M.: Short-term forecast improvement of maximum temperature by state-space model approach: the study case of the TO CHAIR project. Stoch Environ Res Risk Assess 37, pp. 219--231 (2023) \url{https://doi.org/10.1007/s00477-022-02290-3}

\bibitem{teu} Teunissen, P.J.G., Khodabandeh, A., Psychas, D.: A generalized Kalman filter with its precision in recursive form when the stochastic model is misspecified. J Geod 95, 108 (2021) \url{https://doi.org/10.1007/s00190-021-01562-0}

\bibitem{huang} Huang, Y., Zhang, Y., Zhao, Y., Shi, P., Chambers, J. A.: A Novel Outlier-Robust Kalman Filtering Framework Based on Statistical Similarity Measure, in IEEE Transactions on Automatic Control, vol. 66, no. 6, pp. 2677--2692 (2021) \url{https://doi.org/10.1109/TAC.2020.3011443}

\bibitem{methe} Auger-Méthé, M., Field, C., Albertsen, C. M., Derocher, A. E., Lewis, M. A., Jonsen, I. D., Flemming, J. M.: State-space models' dirty little secrets: even simple linear Gaussian models can have estimation problems. Scientific Reports, 6, 26677 (2016) \url{https://doi.org/10.1038/srep26677}

[1424] *Adjustment of Gauss-Helmert Models with Gaussian Errors and Data Gaps*

Prof. Boris Kargoll (Fachbereich Architektur, Facility Management und Geoinformation Hochschule Anhalt), Dr. Mohammad Omidalizarandi (Geodteic Institute, Leibniz Universitaet Hannover) and Pd Dr. Hamza Alkhatib (Geodteic Institute, Leibniz Universitaet Hannover).

Data gaps are a common issue in time series and other temporal or spatial data sets that must be addressed to ensure accurate analysis and modeling. However, simply removing gaps from the data set can result in a loss of regular spacing between observations and a corresponding structure of the variance-covariance matrix. In geodetic applications, data gaps may occur due to sensor defects or insufficient sensor standpoints during measurements, leading to non-constant sampling rates in time series data or discontinuities in spatial data such as curves or surfaces.

Traditional correlation models such as autoregressive observation or noise models are often not applicable when regularly spaced observations have gaps. Common methods of filling gaps, such as using zeros, can also be problematic as they may be grossly unrealistic and distort parameter estimates. Fortunately, there are several methods for filling data gaps that can lead to more accurate results. These methods include using observations surveyed by a different sensor, using values of a mathematical function, using a mathematical covariance function, or using predictions derived from machine learning algorithms based on a stochastic observation model. In geostatistics, data gaps may occur in locations inaccessible to direct measurement, making it necessary to predict the missing observations using a covariance function, possibly in connection with a deterministic trend model. However, in this study, we focus on predicting missing observations to achieve optimal parameter estimation in adjustment calculus. We use a set of n measurements $\mathbf{y}$ to estimate implicit models involving u parameters $\boldsymbol{\beta}$, with the individual measurements arranged within the vector $\mathbf{y}_o$ consisting of r available observations and the vector $\mathbf{y}_m$ consisting of $n-r$ missing observations.

Our approach assumes that the complete data $[\mathbf{y}_o^T, \mathbf{y}_m^T]^T$ are additive combinations of true (error-free) observations $\boldsymbol{\mu}_o,\boldsymbol{\mu}_m$ and errors $\mathbf{e}_o,\mathbf{e}_m$. We treat the true observations as additional parameters to be estimated and define the implicit model using constraint equations. We use a constrained expectation maximization approach to ensure optimal results, requiring the constraints to be linearly independent and the normal equation matrices to be well-defined.

To complete our Gauss-Helmert model (GHM), we specify a stochastic model for the errors. We assume that the errors $[\mathbf{e}_o^T, \mathbf{e}_m^T]^T$ follow a multivariate normal distribution with expectations of 0 and a variance-covariance matrix (VCM) $\boldsymbol{\Sigma}$. By applying error propagation to our equation, we can show that the observations follow a multivariate normal distribution. The constraints and the preceding stochastic observation model together make up a "Gauss-Helmert model (GHM) with normally distributed random deviations and missing data." The VCM $\boldsymbol{\Sigma}$ depends on user specifications and may involve additional parameters such as a variance factor σ^2 or variance components.

In this paper, the proposed algorithm for handling data gaps is applied to simulated data sets and real applications using measurements obtained from a laser tracker containing data gaps. The practical relevance of this sphere parameter estimation can be seen in the field of surface fitting applications and referencing applications of surface and point-wise measuring sensors, i.e., laser scanner and laser tracker measurements.

Overall, our approach provides a robust and accurate method for filling data gaps in time series and other temporal or spatial data sets. By using a constrained expectation maximization approach and specifying a stochastic error model, we can ensure optimal parameter estimation, and accurate and reliable modeling, even in the presence of missing data.

[1459] COMPARISON OF PRIVATIZATION IN THE REPUBLIC OF CROATIA AND SELECTED FORMER COMMUNIST COUNTRIES

Helena Nikolic (FACULTY OF ECONONOMICS AND BUSINESS, UNIVERSITY OF ZAGREB) and Jan Horacek (Electrolux d.o.o.).

The paper deals with privatization processes in five selected countries of the communist regime and their comparative analysis. Most countries have historically encountered the need to privatize state-owned enterprises. A closed and inefficient economic system would reach the brink of resilience and change was necessary. Privatization was a conceptual solution. Due to diversified economic systems, internal social and political differences, as well as the complexity of the privatization process itself, the ways in which it is implemented vary greatly from country to country. However, the aspiration has generally always meant overall economic improvement, and the implementation of rapid, formal, as painless as possible, preferably spontaneous, and transparent privatization. Still, everything took place in several stages and there was a mass, and most often coupon privatization, in one of the phases. It was concluded that each privatization process is specific, but there are still some overlaps. The main distinguishing criteria are related to the approach towards privatization (modular or inflexible) as well as centralization (Croatia, Czechoslovakia, and Poland) and the decentralization (Slovenia and Hungary) of the system that implements and controls privatization. Also, in some countries there is a lack of public support due to numerous embezzlements, frauds and attempts to exploit positions of power at a given time, while on the other hand orderliness, legitimacy, and innovation result in inflow of foreign capital and successful privatization supported by the public.

[1531] Sentiment analysis based on multifractal methods

Mariia Chuprina (NUST MISiS) and Valeriya Shikheyeva (NUST MISiS).

Sentiment analysis, which allows to extract the author's opinion, is a crucial and urgent area of research. For some corporate platforms, this topic is particularly relevant because using the analysis of public opinion, it is possible to clearly understand the real and objective needs of users. For users, the emotional analysis of positive and negative comments can also become an important reference information for choosing appropriate services or products. Embedding methods are used to represent words as vectors that reflect the unique features of words and the semantic relationship between them. By averaging these vectors in a sentence, one can obtain a vector representation of the sentence that reflects its meaning. To date, there are many approaches to the analysis of feature vectors and the prediction of text emotions, for example, machine learning or neural networks. However, these approaches have their drawbacks: using machine learning models, you can get low prediction accuracy, while neural networks need to be trained on a dataset with a large amount of data. Also, using full vector spaces is an inefficient approach, since computational complexity and the influence of noise on classification results increase. Using the multifractal method (MF-DMA, MF-DFA) will not only reduce the dimension of the vector space, but also highlight the semantic features of the text. The feature vectors of sentences are represented as time series, over which the Hurst exponents are calculated. The resulting reduced-dimensionality vectors serves as input for machine learning models (e.g., SVM or Random Forest) for binary classification. Our study showed that the researched time series have multifractal properties, and there is a clear separation of the Hurst exponents for positive and negative comments. Thus, this approach solves the problems of neural networks and machine learning, because it is possible to more accurately predict text emotions without extensive data.

[1534] Impact of Recent Crises on Inter-linkages across International Currencies

Shipra Bhatia (Indian Institute of Foreign Trade) and Dr Divya Tuteja (Indian Institute of Foreign Trade).

This paper examines the dynamic linkages amongst international currency markets in the face of crisis episodes including the global financial crisis, the eurozone debt crisis and, the recent COVID-19 pandemic. We utilize weekly data from August 2005 till October 2021. Our empirical strategy involves the identification of crisis periods using a Markov-switching model. This is followed by the estimation of the dynamic conditional correlations using a DCC-GARCH model. Finally, we test for the impact of the crises using a regression model with robust standard errors. We compare the impact of the crises on the dynamic correlations across the currency markets. Our findings suggest that the correlation between developed economy exchange rates increased significantly during GFC, ESDC, and Covid-19 implying a contagion effect. While significant negative correlation coefficients were observed across all pairs of Japanese Yen during GFC and ESDC, indicating the flight to quality.

[1543] *Defining Sports Performance by Using Automated Machine-Learning System*

Kalle Saastamoinen (National Defence University of Finland/Military Technology), Tuomas Alanen (Naval Academy), Pasi Leskinen (Naval Academy), Kai Pihlainen (Training Division, Defence Command, Finnish Defence Forces) and Joona Jehkonen (Shared Service Center, Information Management, Finnish Defence Forces).

We wanted to find out if we could use an automated machine learning sys-tem called Azure for the selection process and placement of conscript train-ing in such a way that AI can make decisions for the right conscript training program individually. To test this we had four separate datasets and access to the Microsoft Azure automated machine-learning environment.

According to the test sets we performed, we see that using automated ma-chine-learning environment it was possible to reach the precision level of the decisions we wanted. Main obstacle was not the used automated machine-learning environment itself, but the quality of the data used for learning. We also made improvement suggestions how to collect data and what kind of da-ta we should measure to make predictive data analysis to work more easily and be more usable in the future.

[1590] *Sim-to-Real Transfer in Deep Learning for Agitation Evaluation of Biogas Power Plants*

Andreas Heller (FH Münster), Peter Glösekötter (FH Münster), Sven Annas (FH Münster), Lukas Buntkiel (Helmholtz-Zentrum Dresden Rossendorf) and Sebastian Reinecke (Helmholtz-Zentrum Dresden Rossendorf).

Biogas is an important driver in carbon-neutral energy sources, many biogas digestor setups, however, are not well optimized and waste energy, or have the potential for more gas output. To optimize these systems, a pipeline has been developed to measure and predict digestor systems' efficiencies by closely monitoring fluid movements. This pipeline includes numerical calculation of fluid behavior (Computational Fluid Dynamics - CFD), and Deep Learning to estimate fluid shear rates introduced by the agitation action. Additionally, a novel measurement system is presented, that can measure the same metrics that were simulated, but in real-world environments. Lastly, an outlook is given, that presents an extension of the here presented setup to further minimize measuring efforts, and recommend optimization approaches to the user.

[1610] *Novel high dimensional time series methods*

Ivor Cribben (University of Alberta).

Identifying change points in dynamic network structures between multivariate time series has become increasingly popular across various domains, from neuroscience to telecommunication to finance. In this talk, we introduce two new methods for estimating network structural change points between multivariate time series. The first method uses non-negative matrix factorization, an unsupervised dimension reduction technique, and a new binary search algorithm to identify multiple change points. The second method considers changes in vine copula structure, various state-of-the-art segmentation methods to identify multiple change points, and a likelihood ratio test or the stationary bootstrap for inference. The vine copulas allow for various forms of dependence. We apply both methods to simulated, financial and to functional magnetic resonance imaging (fMRI) data sets. Time permitting, I will also discuss some recent work on reproducibility in statistics by attempting to reproduce the results in 93 published papers in prominent journals utilizing functional magnetic resonance imaging (fMRI) time series data during the 2010-2021 period.

[1825] *Analyzing Mobility Patterns of Complex Chronic Patients Using Wearable Activity Trackers: A Machine Learning Approach*

Alejandro Polo Molina (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Eugenio Francisco Sánchez Úbeda (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), José Portela González (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Rafael Palacios Hielscher (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Carlos Rodríguez-Morcillo García (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Antonio Muñoz San Roque (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Celia Álvarez Romero (Computational Health Informatics Group, Institute of Biomedicine of Seville) and Carlos Hernández Quiles (Internal Medicine Department, Virgen del Rocio University Hospital).

This study suggests using wearable activity trackers to identify mobility patterns in Chronic Complex Patients (CCP) and investigate their relation with the Barthel Index (BI) for assessing functional decline. CCP are individuals who suffer from multiple, chronic health conditions that often lead to a progressive decline in their functional capacity. As a result, CCP frequently require the use of healthcare and social resources, which can place a significant challenge on the healthcare system. Evaluating mobility patterns is critical for determining CCP's functional capacity and prognosis. In order to monitor the overall activity levels of CCP, wearables activity trackers are proposed. Utilizing the data gathered by the wearables, time series clustering with Dynamic Time Warping (DTW) is employed to generate synchronized mobility patterns of mean activity and coefficient of variation profiles. The research has revealed distinct patterns in individuals' walking habits, including the time of day they walk, whether they walk continuously or intermittently, and their relation to BI. These findings could significantly enhance CCP's quality of care by providing a valuable tool for personalizing treatment and care plans.

[1972] *Goal-Oriented Transformer to Predict Context-aware Trajectories in Urban Scenarios*

Álvaro Quintanar (Universidad de Alcalá), Rubén Izquierdo (Universidad de Alcalá), Ignacio Parra (Universidad de Alcalá) and David Fernández-Llorca (European Commission, Joint Research Centre).

The accurate prediction of road user behavior is of paramount importance for the design and implementation of effective trajectory prediction systems. Advances in this domain have recently been centered on incorporating the social interactions between agents in a scene through the use of RNNs. Transformers have become a very useful alternative to solve this problem by making use of positional information in a straightforward fashion. The proposed model leverages positional information together with underlying information of the scenario through goals in the digital map, in addition to the velocity and heading of the agent, for predicting vehicle trajectories in a prediction horizon of up to 5 seconds. This approach allows the model to generate multimodal trajectories, considering different possible actions for each agent, being tested on a variety of urban scenarios, including intersections, and roundabouts, achieving state-of-the-art performance in terms of generalization capability, providing an alternative to more complex models.

[1995] *Dynamic Tikhonov State Forecasting based on Large-Scale Deep Neural Networks Constraints*

Cristhian Daniel Molina-Machado (Instituto Tecnologico Metropolitano), Juan David Martinez-Vargas (Universidad EAFIT) and Eduardo Giraldo (Universidad Tecnológica de Pereira).

In this work is presented a dynamic Tikhonov state forecasting based on large-scale deep neural networks constraint for the solution of a dynamic inverse problem of electroencephalographic brain mapping. The dynamic constraint is obtained by using a large scale deep neural network to approximate the dynamic of the state evolution in a discrete large scale state-space model. An evaluation by using neural networks with several hidden layers configurations is performed in order to obtain the adequate structure for large scale system dynamics tracking. The proposed approach is evaluated over two models of 2004 and 10016 states in discrete-time. The models are related to an electroencephalographic problem for EEG generation. A comparison analysis is performed by using static an dynamic Tikhonov approaches with simplified dynamic constraints. By considering the obtained results it can be concluded that the deep neural networks adequately approximate large scale state dynamics by improving the dynamic inverse problem solutions.

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[2003] *Predicting Safety- Critical Events in Traffic Flow Based on Time-Series*

Jamal Raiyn (Al Qasemi Academic College) and Amgad Seif (Al Qasemi Academic College).

This paper introduces a new method for identifying safety- critical- events in time-series data. Safety-critical events are difficult to define and are for the most part uncontrollable; however, they can be recognized at an early stage and prevented. Nowadays, the most common method for identifying safety-critical involves the analysis of real-time naturalistic driving data. A large number of accidents result from vehicles' changing lanes. Delays in drivers' reaction times and errors of judgement are the main causes of the vast majority of accidents. This paper discusses the impacts of failed lane- changing and sudden acceleration in platooning congestion. A time- series forecasting algorithm is proposed, which uses statistical analysis tools based on kinematic triggers to identify failed lane-changing to predict and help prevent safety-critical events.

[2014] *Automated Approach for Generating and Evaluating Traffic Incident Response Plans*

Adel Almohammad (University of Wolverhampton) and Panos Georgakis (University of Wolverhampton).

Traffic incidents usually have negative effects on transportation system such as delay and traffic jam. Therefore, traffic incident response plan can guide management actors and operators to take actions effectively and timely after traffic incidents. In this paper, an approach has been proposed to generate and evaluate traffic incident response plans automatically when a traffic incident is detected. In this approach, a library of response action templates has been constructed beforehand to be used in the real time generation process of response plan template. According to the type and severity of the detected and confirmed traffic incident, a combination of relevant response action templates provides a set of response plans. Also, we developed a simulation model for the study area by using Aimsun Next software to evaluate the performance of generated response plans. Therefore, the simulation outcomes determined the rank of generated response plans including the optimal response plans. The proposed approach considered the characteristics of input traffic incident and transport road network to generate the response plans. Furthermore, the choice of the optimal response plans considered the characteristics of the input traffic incident. The implementation results show that the generated response plans can enhance and improve the overall network performance and conditions efficiently. Also, the response plans ranking is considered to be a supportive tool in the network operators' decision making process in terms of the optimal response plan to be implement or propagated.

[2032] *Evaluation of Heuristics for Taken's Theorem Hyper-Parameters Optimization in Regression Tasks*

Rodrigo Hernández-Mazariegos (UMSNH), Jesus Ortiz-Bejar (MatterTalent) and Jose Ortiz-Bejar (UMSNH).

This study compares three methods for optimizing hyper- parameters m (embedding dimension) and τ (time delay) from Taken's Theorem for time-series forecasting to train a Support Vector Regression system (SVR)[4]. Firstly, we use a method proposed in [1], which utilizes Mutual Information for optimizing τ and a technique referred to as "Dimension Congruence" to optimize m. Secondly, we employ a grid search [2] and random search [3], combined with a cross-validation scheme to optimize m and τ hyper-parameters. Lastly, various real-world time series are used to analyze the three proposed strategies.

[2049] *A forecasting model for the prediction of system imbalance in the Greek power system*

Konstantinos Plakas (Department of Electrical and Computer Engineering, University of Patras), Nikos Andriopoulos (Department of Electrical and Computer Engineering, University of Patras), Alexios Birbas (Department of Electrical and Computer Engineering, University of Patras), Ioannis Moraitis (Department of Research, Technology & Development, IPTO) and Alex Papalexopoulos (Ecco International Inc.).

Forecasting imbalance volumes are of great importance for different actors in the electricity markets. From the Transmission System Operator (TSO) perspective, balancing in real-time supply and demand is one of the main operational tasks to ensure the safe and reliable operation of the power system, while market participants also use forecasting tools to enhance their participation strategy in the electricity wholesale markets. Over the last few years, the increasing integration of renewable energy sources into the power system has created additional complexity in the

problem of determining accurately the imbalance volume. In the present work, a case study of the Greek balancing market is presented and analysed. Different algorithms and a set of external predictors are adopted both from the market and operationally perspective and compared for two different forecasting horizons.

[2058] *An evaluation of the past and future expected wind climate in the Mediterranean and the Black Seas*

Eugen Rusu ("Dunărea de Jos" University of Galati).

Visible changes of the climate can be noticed in the last decades and the environmental matrix is moving fast indicating both high gradients and extreme values of the environmental parameters. Taking into account this obvious dynamics, the European Green Deal (EGD) has been publically released in December 2019. This is a programmatic document, which assumes effective measures that should be taken in the European Union for taking the green road in the direction of de carbonization. In this context, a special place is related to a significant enhancement of the offshore renewable energy exploitation, and especially of the wind power. Around 60 wind farms already operate in the northern European coastal environment [1], where actually the first wind project in the world was installed more than 30 years ago. On the other hand, unlike in the north, along the southern coasts of Europe the first wind project became operational in 2022 in the Mediterranean Sea in Italian waters near Taranto harbor. Following the very ambitious EGD targets, according to which the exploitation capacity of the offshore wind should increase in the European nearshore 25 times until 2050 in relationship with 2021, various other wind projects are currently planned both in the Mediterranean and Black Seas.

From this perspective, the objective of the present work was to assess the past and future expected wind climate in the southern European seas, the Mediterranean and Black Seas. The analysis of the wind fields is structured on three periods, each of 30 years. The first is related to the recent past period (1976-2005), and it is based on ERA5 hindcast wind data [2]. For the expected future wind climate, two different time intervals have been considered, the 30-year interval 2041-2070, denoted as near future, and the next time interval of 30 years until the end of the 21st century (2071-2100), which is referred in the present work as distant future. For these two time intervals, data from Regional Climate Models (RCMs) have been processed and analyzed. These include especially, RCA4 [3] (Rossby Centre regional atmospheric model, version 4) operated by the Swedish Meteorological and Hydrological Institute. At the same time, data provided by other RCMs have been processed and analyzed in order to compare the results, as for example CNRM-ALADIN63 [4] operated by Centre National de Recherches Météorologiques, France. As regards the climate scenarios, both RCP4.5, this can be considered as the realistic approach, and RCP8.5, the so called pessimistic approach, have been considered. The analysis of the RCM data started with a comparison for the historical period between the ERA5 wind fields and those provided by the RCMs in order to evaluate the differences. The results indicate that RCA4 data are closer with ERA5 than ALADIN. On the other hand, all models indicate the same geographical spaces as having a higher wind potential. These are the Gulf of Lion and the southeast Iberian nearshore in the Mediterranean Sea, and the northwestern and western coasts in the Black Sea. The potential of these areas is comparable with that from the Baltic Sea [5] and thus looks very appropriate for the wind energy extraction.

As regards the expected future wind climate, the RCM results indicate a slight enhancement in terms of the average wind speeds on large geographical spaces, including the hot energy spots identified, and this enhancement is expected to be relatively higher in the near future time interval. Another issue targeted in the present work is related to the extreme wind speeds. The analysis indicates also that the frequency and intensity of the extreme events is expected to increase in the near future in the two seas and this enhancement will be higher in the Black Sea, where some storms may become very similar with the hurricanes, both from the point of view of their cyclonic configuration and wind speed.

[2082] *Social Network Analysis and Polyamory*

Janet Bennion (Northern Vermont University).

In this paper, I use Social Network Theory to analyze the unique links of love and friendship between females and metamours (lover's lovers) in a Parisian polyamory community. Previously, such networks have only been applied to fictional polycules, or love networks, such as the L Word or Game of Thrones. In the Paris networks, there exists a vast web of nodes connected in much more intimate and complex ways than one finds in the mono-normative landscape. Using participant-observation, informal and structured interviews, and social network analysis, my data showed that cis- and trans-women, with a strong sense of family and skills in interpersonal communication, score highest on network metrics of density/degree, homophily, transitivity, and "indirectedness," a new term synonymous with bridging ties as an important measure of centrality. The network data also indicate high modularity and endogamy with clustering

tendencies for both cis-men and cis- and trans-women linked to kink, atypical intelligence, sexual and gender non-conformity, and mitigating factors of socioeconomic advantage and racial privilege.

[2119] *Green Deal Goals versus Financial Performance: the Case of Euro Stoxx 50 Companies*

Raminta Vaitiekuniene (Kaunas University of Technology).

The European green deal envisages ensuring climate neutrality by 2050. This includes a modern and competitive economy based on the environment, climate, transport, energy, industry, agriculture, and sustainable finance. Corporates are playing a very important role in this whole process. Therefore, the purpose of the research is to evaluate the performance of the largest European corporates, revealing how corporates contribute or do not contribute to the implementation of the green deal. Systematization of scientific literature, selection of input and output variables based on the results of scientific literature, and analysis of statistical relationships as the main research methods are applied to achieve the purpose. The results of the article show that the largest European companies, selected from the most significant European stock index Euro Stoxx 50, do not equally contribute to the implementation of the green deal. The companies' environmental, social, and governance indicator (ESG), which reflects the level of the company's green deal, ranges on average between 35.90 and 65.05 points. The highest score was achieved in Euro Stoxx 50 utilities sec-tor companies (65.05 points), and the lowest score in real estate and communication services sector companies (accordingly, 35.90 points and 41.36 points). Part of the analyzed corporates from the consumer discretionary, financials, industrials, information technology, and real estate sectors could contribute more to the improvement of a sustainable environment and social responsibility, as these corporates demonstrate better financial performance. On the other hand, corporates from the consumer staples and materials sectors that are already actively contributing to the implementation of the green deal do not necessarily have accumulated greater financial resources.

[2175] *Applying Data Mining and Machine Learning Techniques to Predict Powerlifting Results*

Jorge Medina Romero (University of Granada), Antonio Mora García (University of Granada), Juan Francisco Valenzuela Valdés (University of Granada) and Pedro Castillo Valdivieso (University of Granada).

This paper presents a study for the creation of a tool to help Powerlifting athletes and coaches as well as bodybuilders and other amateur gym athletes to analyse their data, provides useful information regarding the athlete's performance. The tool should also predict future personal records in the lifts for both raw (non-equipped) and non-raw (equipped) attempts, and their various exercises. In order to achieve this, a dataset with entries of around 500k lifters and more than 20k official Powerlifting competitions have been used. Among those entries, biometric variables of the lifters and the weights they lift in each of the three movements of this sport discipline have been included. That is: Squat, Bench press and Deadlift. We have applied data preprocessing and visualising as well as data splitting and scaling techniques in order to train the Machine Learning models that will make the predictions. Lastly, the best predicting models have been used in the implemented tool.

[2177] *Using Risk Terrain Modeling for the risk assessment of explosive ATM attacks*

Katharina Schwarz (Criminological Research Department of the State Office of Criminal Investigation North Rhine-Westphalia) and Kai Seidensticker (Criminological Research Department of the State Office of Criminal Investigation North Rhine-Westphalia).

1 Introduction In recent years, explosive ATM attacks have become a major issue in Germany. In 2022, more than a third of all explosive ATM attacks recorded throughout Germany, were committed in North Rhine-Westphalia. In a nationwide comparison, North Rhine-Westphalia is thus the most severely affected federal state. This can be attributed in particular to the large number of opportunities to commit the crime: more than 10,000 ATMs, the good opportunities to escape due to the dense, well-developed road network, and the proximity to the border with the Netherlands – the perpetrators are predominantly members of Dutch criminal groups. Predicting the occurrence of these crimes is crucial for law enforcement agencies to allocate resources effectively and prevent losses for banks and customers. To address this problem, law enforcement agencies need to be able to predict where and when these crimes are likely to occur. In recent years, various prediction models have been developed to tackle this issue, but their effectiveness remains to be proven. Risk Terrain Modeling (RTM) methods are able to assess the risk of future crime occurrence from a spatial perspective. This approach is part of the SKALA (System for Crime Analysis and Anticipation) approach of the State Office of Criminal

Investigation of North Rhine-Westphalia (LKA NRW). The intention of SKALA is to understand the main use of crime analysis and forecast algorithms to investigate crime patterns at different spatial and temporal scales to support crime prevention (Seidensticker & Schwarz, 2022). The findings concerning the risk assessment of explosive ATM attacks using RTM are presented and discussed below. 2 Using RTM for modeling the risk of explosive ATM attacks In this paper, we propose the use of RTM methods to predict ATM attacks in Germany as a data-driven method for the risk assessment of crime in space. RTM uses crime and environmental data to identify areas with a higher risk for crime occurrence (e.g. Perry et al., 2013). The methodical approach of RTM typically involves the following steps: 1. Data Collection: Collect crime and environmental data relevant to the area of interest. This data may include information on crime type, location, time of day, and environmental features such as socioeconomic information, traffic, and building use. 2. Data Preprocessing: Clean, normalize and transform the collected data to prepare it for analysis. This may involve dealing with missing values, outliers, and inconsistencies in the data. 3. Model Development: Build a statistical model that incorporates the environmental features identified in the data to predict the likelihood of crime occurrence. This may also involve using machine learning algorithms such as random forests, gradient boosting, or neural networks. 4. Validation: Test the model using cross-validation techniques to ensure its accuracy and robustness. The model was validated by using a separate dataset not used during the training process to avoid overfitting. 5. Deployment: Use the model to generate risk maps for the area of interest, which can be used to guide resource allocation, crime prevention strategies, and to identify high-risk areas for further study. 6. Monitoring and Maintenance: Regularly monitor the model performance and update it as needed to ensure its accuracy over time.

In addition to the spatial approach, temporal factors were included to account for the temporal variability of explosive ATM attacks. For this purpose, seasonality, the weekly cycle, and also methods such as Recapture Rate Index (RRI) and Auto-Regressive Integrated Moving Average (ARIMA) were included. The risk of explosive ATM attacks is classified in three classes (class 1: high risk; class 2: medium risk; class 3: moderate risk) to select the ATMs with the highest risk for action by the police, such as prevention measures. 3 Results The results show that RTM methods can provide accurate predictions of explosive ATM attacks in Germany and can be used to improve resource allocation and prevention strategies. By capturing patterns in time series data, RTM methods can identify areas and times of where and when explosive ATM attacks are likely to occur, allowing law enforcement agencies to allocate resources effectively and prevent losses for banks and customers. The model accuracy was determined by means of retrograde analyses. This involves determining the risk for an earlier valuation date and evaluating it on the basis of future transactions on the reporting date. Taking into account the ATMs with at least an increased risk (risk classes 1 and 2), the risk assessment shows a model accuracy of 87%. If only the ATMs with the highest risk are taken into account (risk class 1), the model has an accuracy of 41%. 3 Potential and Limitations The potential benefits of using RTM methods to predict explosive ATM attacks are clear. By using RTM, police are able to better allocate their resources by focusing their efforts on ATM of increased risk. Moreover, the use of RTM provides the police with a deeper understanding of the patterns and trends associated with explosive ATM attacks and empowers them to develop more effective prevention strategies. However, there are also limitations to the approach that need to be considered. For example, RTM methods may be limited by the quality and availability of data and may not capture all relevant factors that influence the occurrence of explosive ATM attacks. In conclusion, our results demonstrate the potential of RTM methods to predict explosive ATM attacks in Germany and provide valuable insights for law enforcement agencies. By combining RTM methods with the SKALA approach, we can provide accurate predictions of explosive ATM attacks and support effective resource allocation and prevention strategies. Overall, crime forecasting methods offer a wide range of possible applications that enable criminal expertise to be enriched by scientific findings.

Perry, W.; McInnis, B.; Price, C.; Smith, S.; Hollywood, J. Predictive Policing. The Role of Crime Forecasting in Law Enforcement Operations; RAND Corporation: Santa Monica, CA, USA, 2013. Seidensticker, Kai; Schwarz, Katharina, Using Forecast Methods on Crime Data: The SKALA Approach of the State Office for Criminal Investigation of North Rhine-Westphalia. Engineering Proceedings 2022, 18(1), 39.

[2204] *It can't get no worse: Using Twitter data to improve GDP estimates for developing countries*

Agustin Indaco (Carnegie Mellon University in Qatar).

This paper shows that we can use social media data to improve the accuracy of GDP estimates at the country level for developing countries. I use all publicly available image tweets from 2012 and 2013 to estimate GDP at the country level for developing countries. First, I find that one can explain 76 percent of the cross-country variation in GDP with the volume of tweets sent from each country. I then show that the residuals on these Twitter-GDP estimates are significantly

larger for countries with allegedly poor data quality. I then use Nigeria as a case-study to show that this method delivers much more timely and accurate estimates than those presented by official statistic agencies.

[2350] *Using Machine Learning Models to Predict Groundwater Potentiality in a Large Mountainous Region under Semi-Arid Climate*

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Water scarcity, especially in arid and semi-arid zones, is a major global issue affecting both drinking and irrigation water. To mitigate human suffering caused by this scarcity, groundwater could be used as an alternative and additional source of water supply in rural areas. This study aims to facilitate groundwater potentiality mapping using spatial-modelling techniques and machine-learning models, including Random Forest (RF), Logistic Regression (LR), Decision Tree (DT), and Artificial Neural Networks (ANNs). The study used 11 ensembles of models to prepare groundwater potentiality maps, with 374 groundwater springs identified and inventoried in the mountainous area. The spring inventory data was divided into training (75%) and testing (25%) datasets, and 24 Groundwater Influencing Factors (GIFs) were selected based on multicollinearity testing and information gain calculation. The groundwater potentiality maps' results were validated using statistical measures and the receiver operating characteristic curve (ROC) method. Finally, the 15 models were ranked using the compound factor (CF) method, with ensembles of models proving the most stable and suitable for groundwater potentiality mapping in mountainous aquifers. The RF-LR-DT-ANN ensemble of models was found to be the most efficient using the area under the curve validation method. The prioritization rank method indicated that the best models were the RF-DT and RF-LR-DT ensembles of models.

[2387] *Improving Data Assimilation for Satellite Data in Hydrodynamic Modeling*

Taha Aawar (Indain Institute of Technology Delhi).

Satellite data assimilation is a vital technique for enhancing the accuracy of hydrodynamic models. Nevertheless, prior approaches have had their efficacy constrained by utilizing satellite data from a single source, the difficulties associated with integrating data from diverse sources, and the uncertainties linked with the hydrodynamic model. This study proposes a novel approach to data assimilation that leverages multiple sources of satellite data and the LISFLOOD model by utilizing the Ensemble Kalman filter algorithm to surmount these challenges. The proposed method incorporates SWOT, geodetic satellite data, and satellite images to provide a more comprehensive system perspective. The Ensemble Kalman filter algorithm compensates for the differences in data resolution and incorporation of error estimations for every data source. This facilitates more precise and consistent assimilation of satellite data from diverse sources. The LISFLOOD model is used to simulate the hydrodynamic processes since it has demonstrated effectiveness in simulating various hydrodynamic phenomena. The Ensemble Kalman filter algorithm can compensate for the uncertainties associated with the model parameters, thus allowing for a more robust and accurate assimilation of satellite data. Overall, the proposed approach represents a substantial improvement over prior techniques for data assimilation utilizing satellite data. By integrating multiple sources of satellite data and the LISFLOOD model with the Ensemble Kalman filter algorithm, this study endeavors to enhance the accuracy and reliability of hydrodynamic models and advance our comprehension of intricate coastal and riverine systems.

[2421] *Could data frequency imply better forecast performance for stock markets? A case study for G7 economies*

Diana Mendes (ISCTE-IUL and BRU-IUL), Nuno Ferreira (ISCTE-IUL and BRU-IUL) and Vivaldo Mendes (ISCTE-IUL and BRU-IUL).

The analysis and prediction of stock markets are critical issues for suitable investments and financial cooperation. However, due to non-stationary, high volatility, and complex nonlinear patterns of stock market fluctuation, it is pretty demanding to predict the stock price accurately. Nowadays, hybrid and ensemble models based on machine learning and economics replicate several patterns learned from the time series and sum the relevant information, improving the

forecast performance. This paper discusses and analyses different models for stock price forecasting. First, we use SARIMAX models in a classical approach and by using AutoML algorithms from the Darts library. Second, a deep learning procedure predicts the stock prices for the seven world's most representative economies (G7). In particular, LSTM (Long Short Term Memory) and BiLSTM recurrent neural networks (with and without stacking), with optimized hyperparameters architecture by KerasTuner, in the context of different time-frequency data (with and without mixed frequencies) are implemented. Several research papers and reports deal with daily data. However, this issue of daily data can be largely dependent on deterministic variables like day-of-week, week-of-the-year, month-of-the-year, week-of-the-month, and long weekends. Furthermore, there may be changes in daily patterns and different volatilities for additional days of the week due to macroeconomic factors, fundamental factors, and investor sentiment. Consequently, it follows the high interest in the multi-step-ahead stock price index forecasting by using different time frequencies (daily, one-minute, five-minute, and ten-minute granularity), focusing on raising intraday stock market prices. The results show that the BiLSTM model forecast outperforms the benchmark models –the random walk and SARIMAX - and slightly improves LSTM. More specifically, the average reduction in error rates by BiLSTM is 14-17 percent compared to SARIMAX. According to the scientific literature, we also obtained that high-frequency data improve the forecast accuracy by 3-4% compared with daily data since we have some insights about the volatility driving forces.

[2459] *Assessment of minimum water level in Lake Volvi based on morphological and hydrological features*

Charalampos Doulgeris (ELGO DIMITRA/Soil & Water Resources Institute) and Rafaela Nikolaidou (ELGO DIMITRA/Soil & Water Resources Institute).

Water bodies support society's economic activities but also puts pressure on aquatic ecosystems of lakes and reservoirs. Therefore, the assessment of a minimum water level, that is, the critical level below which no further withdrawal should take place, is a key factor for the sustainable management and protection of their ecosystem. Despite the importance of defining a minimum water level in lakes and wetlands, there are only few assessment methods available. In addition, minimum water level assessment methods have rarely been used to assist water resources management in lake ecosystems. In this work, a morphological analysis based on the lake surface area-volume relationship and a hydromorphological analysis based on the water surface area–volume relationship and the water inflows from the hydrological catchment area are evaluated to assess the environmentally minimum water level of Lake Volvi in Central Macedonia, Greece.

[2485] *The effect analysis of price elasticity on the forcast of agricultural determinants using the Nerlove model*

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The agricultural sector has always been one of the Ivorian economy pillars. As the world's leading producer of cocoa beans and cashew nuts, Côte d'Ivoire is a key player in this sector. Export agriculture (coffee and cocoa) has long been the mainstay of the economy. Despite the emergence of a growing industrial fabric and the government's commitment to invest in other sectors such as education, Ivorian agriculture continues to contribute significantly to government revenues. Thus, in 2018, the agricultural sector represents 28% of Côte d'Ivoire's GDP and 40% of the country's exports (56% in 2012), 62% excluding oil. The agricultural sector employs 46% of the workforce and provides a living for two-thirds of the population (source: World Bank). After independence, Côte d'Ivoire inherited the cocoa crop, its production was 1.5 million tons in 1964 reached the mark of 4.162 million tons in 2013- 2014 (ICCO, 2014). It has now become one of the most profitable crops in the world, generating in 2008 7, 4 billion US dollars among small producers (ICCO, 2008). In contrast, cashew nuts were introduced in northern Côte d'Ivoire in the late 1950s for reforestation and soil protection. Progressively, from a purely ecological aspect, the establishment of the cashew tree meets a socio-economic need, since this tree can produce marketable nuts. Thus, cashew became a real speculation from the 1990s, due to the increasing demand for cashew nuts on the international market. The cashew sector has thus experienced spectacular development with national production of raw cashew nuts increasing from 19,000 tons in 1990 to about 750,000 tons in 2018 (Conseil du Coton et de l'Anacarde, 2018). In Cote d'Ivoire, the development of the agricultural sector has had a significant and

considerable impact on the economic and social well-being of the population. The economy of Côte d'Ivoire is still based on the exploitation and export of raw materials, mainly agricultural (PND 2016-2020). This economy is much more oriented towards the analysis of agricultural supply. This consists of analyzing the supply response to product prices and to the prices of production factors and intermediate consumption. This analysis also concerns the agricultural income of suppliers (producers). Producers are rational economic agents who offer the total quantity of the good on a market in exchange for a price. Several econometric models have based their studies on the relationship between agricultural determinants such as supply and price. We can cite the work of Nerlove who was the first to develop a theory known as "the Nerlovian models of supply response" in 1956 and 1958. This theory has been used to explain the response of U.S. agricultural producers to perpetual changes in crop prices, macroeconomic policies and many other factors. Nerlove's model has been the subject of several agricultural studies. In Senegal, this model was used to model the prices of cereal products before 1985 and the price of peanuts. The Nerlove model was adapted to analyze the determinants of yam production in the commune of Glazoué in Benin (ADEGNIKA, 2018). DARDENNE (1985) estimated the price elasticities of the main Brazilian agricultural productions from 1966 to 1981 using Nerlove models. The Nerlove models have also been used to model the French grain market (LE ROUX, 1991) This article is part of the econometric modeling and forecasting of agricultural determinants based on the Nerlove model. The first part aims at estimating the price elasticities of the agricultural products cocoa and cashew nuts and analyzing their effects on the forecasting from the Nerlove model. In the second part, we develop an estimation technique for the parameters of the Nerlove model, based on the maximum likelihood method. This study is applied to data on rainfall, agricultural areas and prices paid to farmers in Côte d'Ivoire over the period 1980-2022.

[2566] *FORECASTED SELF: AI-BASED CAREERBOT - SERVICE HELPING STUDENTS IN JOB MARKET DYNAMICS*

Asko Mononen (Laurea University of Applied Sciences), Ari Alamäki (Haaga-Helia University of Applied Sciences), Janne Kauttonen (Haaga-Helia University of Applied Sciences), Aarne Klemetti (Metropolia University of Applied Sciences), Anu Passi-Rauste (HeadAI Ltd) and Harri Ketamo (HeadAI Ltd).

In this article, we introduce AI-enhanced study planning solution named Careerbot, which is a service designed to help students with "forecasted self". We define a new term "forecasted self" meaning future-oriented digital twin, where a student can explore several future selves equipped with new, acquired skills for projected future jobs. We believe the use of this new term and approach will bring the benefits of understanding: 1) the essence of future-orientation; 2) holistic approach of soft skills and hard skills appreciated by employers; 3) skills gap between current skills and the direction to focus in skills acquisition and 4) ability to verbalize one's skills and competences in a concrete language used in job ads by employers (vs. e.g. academic jargon). We also use term skills data as the unifying factor in-between different actors and operations, "skills data describes people's skills, the competence needs of organisations and the competence offerings of educational institutions. In practice, skills data can be found, for example, on employees' CVs, companies' job adverts and course guides." (Skills data playbook, 2022).

We examine the adoption of artificial intelligence (AI) in three applied universities (3AMK) in Finland. More specifically, we analyse and discuss experiences regarding the educational AI-solution that assists higher education students by providing course suggestions, thesis topic trends and job market data for their career and study planning. 3AMK is a strategic alliance between the three largest universities of applied sciences in Finland: Haaga-Helia, Laurea and Metropolia (3amk.fi). 3AMK has about 34 000 students, 2 000 staff and 15 campuses in Helsinki -capital region. In this paper, we conceptualize "forecasted self" based on the analysed experiences in designing and adopting Careerbot AI-enhanced study planning service.

The adoption of AI is rapidly growing as a means to enhance students' personal or collaborative learning and study planning in higher education. The adoption of AI provides new opportunities to develop study planning where AI can model and suggest competence profiles, needs, and requirements from real-time job market data. The prior literature of AI-enhanced learning and teaching show that AI can create value for students and teachers (e.g. Mononen et al., 2021; Popenici & Kerr, 2017; Renz et al., 2020). AI enables personalisation (e.g. Chassignol et al., 2018; Tiihonen & Felfernig, 2017) which is important requirement in improving and customizing learning for the special needs of each students. AI is also widely adopted for students' performance assessment, competence profiling and assessment, finding learning gaps and predicting students' progress in the courses (e.g. Costa, et al. 2017; Ketamo et al., 2019; Yang & Li, 2018).

3AMK have developed Careerbot -service to help their students to pursue their dream careers with the help of AI. The Careerbot -service can help 3AMK students to 1) verbalize their skills with the help of AI (skills profile, currently or "forecasted self" in the future); 2) find jobs with their skills profiles (job market intelligence); 3) find courses for skill

development (upskilling, reskilling), 4) find theses/research topics, trends and content (research intelligence) and 5) Careerbot -service uses the AI –trained language model which has been trained with millions of news articles and e.g. with ESCO-classification. Data sources are a) job market data in Finland (Työmarkkinatori, MOL and Duunitori/employment services) with over 400 000 job ads yearly basis, since January 2018, b) 3AMK course data for all 15 000 courses and c) Theseus –theseus database (120 000+ theses available from Finland since 2010) and global article database (DOAJ with 8,6+ million articles).The language model, foresight data products (curriculum data, labour market data, investment data, research papers) and the AI, Graphmind, behind the service is powered by Finnish tech company HeadAI Ltd. Graphmind is a Graph Machine Learning -based semantic computing framework accessible via REST-API. Basic operations behind the framework are i) building a Digital Twin (personal, curriculum, secanrios), ii) compare two Digital Twins against each other to show similarities and gaps, and iii) recommend interventios from third Digital Twin to bridge the gap. In addition to 3AMK students, also the 3AMK staff have access to service. Lecturers and content creators can ensure their content is up to date. RDI-staff can search research ideas or prior research articles for supporting the new externally funded RDI-projects. Also, career coaching can use Careerbot -service in their career counseling for students, backing up visual cv's with data and vocabulary known by working life.

Below you can see one example map, a zoomable snapshot of the most important hard and soft skills in ICT in the Helsinki-region. The clusters below the bubble chart are the same data in top lists: 15 largest hits in order of relevance. There are currently 19 ready example maps in Finnish and English: 13 job market maps and 6 curriculum maps. The maps are updated in every 1-2 months, which is currently frequent enough to see the changes. The same functionality can visualize the students' skills profile data, so they can e.g. attach the image to their cv's. These maps leverage the semantic language model and its graphical representation of terms. This graph is visualized using a many-body particle simulation model to represent the graph as a collection of 2D non-overlapping disks. Clustering is computed using a weighted community detection algorithm (Clauset et al. 2004).

Figure 1: Zoomable example map in Careerbot -service

In the image below, there are trends from global DOAJ -article database (doaj.org) with search words: artificial intelligence, machine learning, big data. The data is updated currently until 12/2021, so year 2023 shows zero. From the graph we can conclude that out of search results, "machine learning" have been trending clearly above "artificial intelligence" and "big data" in 2021. Prediction tab is used for testing, it calculates the following years based on the historical data and fits a B-spline approximation for the data (Unser et al., 1992).

Figure 2: Searching global DOAJ -article database, trends shown. We contribute to the discussion of AI-enhanced learning and teaching by conceptualizing forecasting self that is a novel concept for digital twin approach in the educational context. Students need to be able to create their own digital competence profile (digital twin) with the help of Careerbot AI-solution that simulates the competence requirements of the up-to date and current job market data.

[2580] *A Simulation Package in VBA to Support Finance Students for Constructing Optimal Portfolios*

Abdulnasser Hatemi-J (UAE University) and Alan Mustafa (IEEE).

This paper introduces a software component created in Visual Basic for Applications (VBA) that can be applied for creating an optimal portfolio using two different methods. The first method is the standard approach that is based on finding budget shares via the minimization of the variance of the underlying portfolio. The second method combines risk and return directly in the optimization problem and yields budget shares that lead to maximizing the risk adjusted return of the portfolio. This approach is consistent with the expectation of the rational investors since these investors consider both risk and return as the fundamental basis for selection of the investment assets. Our package offers another advantage that is usually neglected in the literature, which is the number of assets that should be included in the portfolio. The common practice is to assume that the number of assets is given exogenously when the portfolio is constructed. However, the current software component constructs all possible combinations and thus the investor can figure out empirically which portfolio is the best one among all portfolios considered. The software is consumer friendly via a graphical use interface. An allocation is also provided to demonstrate how the software can be used using real time series data for several assets.

[2668] *Detecting superexponential behaviour in financial asset price returns with applications to trading strategies*

Christopher Lynch (Open Univ, Sch Math & Stat, Milton Keynes MK7 6AA, Bucks, England) and Ben Mestel (Open Univ, Sch Math & Stat, Milton Keynes MK7 6AA, Bucks, England).

A practical algorithm for the detection of bubbles and negative bubbles in financial markets is reviewed and then applied to day-trading of NASDAQ-listed stocks. The results from trading strategies implemented in 2023 area are described. A criterion is derived from the Johansen-Ledoit-Sornette model of asset dynamics that indicates whether a given market is likely to be exhibiting superexponential dynamics (where growth corresponds to an asset price bubble and decline to a negative bubble) as opposed to "normal" exponential behaviour corresponding to a constant rate of growth or decline. The criterion is calculated by linear fitting to observed time-series data with a non-linear time transformation for which parameters are distributed uniformly in their allowed ranges. Since it makes use of expected values rather than the underlying distribution, the criterion is straightforward and efficient to compute and implement.

[2709] *A GENERALIZED BONUS-MALUS SCALES MODEL FOR INSUREDS OF DIFFERENT SIZES*

Jean-Philippe Boucher (Université du Québec à Montréal).

A Bonus-Malus Scales (BMS) model corresponds to a class-system with a finite number of levels, where a relativity is assigned to each level. Depending on the transition rule of the BMS, insureds usually move down by a level if they do not claim during their contract, and move up a specific number of levels for each claim. The insured's level at the end of the year is then used to compute the next annual premium. Some recent papers generalized the BMS models theory using the newly available granular insurance data, which has only recently become available. Even if it has been shown that these new BMS approaches using panel data often offer better fit statistics and predictive measures than those obtained with many advanced panel data models, BMS models still have problems. One is that the rating system may appear unfair to many insureds because it does not recognize the initial risk of the insured. While some authors proposed creating different BMS for each type of insureds, we proposed a unique and general approach to that problem. Based on an improved technique for estimating the parameters of the BMS, we show that the new Generalized BMS model generates surcharges and discounts that depend on the size of the insured, or on the a priori risk. We apply this new generalized BMS model to real data from a major Canadian insurance company for their farm insurance products, where the size of each insured differs significantly.

[2767] *How closely do Australian banks interconnected?*

Gia Huynh (Charles Darwin University), Fennee Chong (Charles Darwin University) and Bharanidharan Shanmugam (Charles Darwin University).

This paper investigates the interconnectivity of Australian banks using the machine learning approach. Specifically, this study's objective is to uncover the volatility connectedness to and from the top 10 banks in Australia. To achieve this objective, daily observations from December 2007 to April 2020 were used. Finding indicated that connectivity between the big 4 banks with each other is much more prominent than with smaller banks. Bigger banks were also found to be exerting a higher magnitude of volatility spillover to smaller banks. Findings also informed that smaller financial institutions were showing lower connectedness among themselves comparing to the much larger institutions. Higher interconnectivity and high volatility transmission between the big 4 banks implying that the probability of all of them going into distress concurrently are high. Furthermore, smaller banks were affected by the performance of the big-4 but not the other way round, this has implication on portfolio management strategy. Machine learning logarithms such as long short-term memory (LSTM), Auto Regressive Integrated Moving Average (ARIMA), and stacked eXtreme Gradient Boosting (XGB) were used to assess prediction efficacy. LSTM was found to be a better method in terms of time series prediction analysis.

[2829] *A combination of visible and infrared sky camera for improving cloud detection and forecasting*

Joaquín Alonso-Montesinos (University of Almería).

In the search of technologies for improving the use of solar energy, remote sensing techniques has been widely employed for different purposes. In that sense, a great variety of resources are available in the market, and whole-sky cameras with fisheye lens have supposed a novel procedure for the solar resource assessment. The hemispherical vision of this kind of cameras provides real-time sky images where the different atmospheric features can be identified. Different sky cameras

have been used over the last decades, having different configurations, and corresponding to different spectral properties. From sophisticated cameras to low-cost cameras, they have been developed for cloud detection, mainly in environments related to energy exploitation, such as solar power plants. In this work, we have combined a visible and an infrared camera that obtain the same representation of the sky, with the aim of being able to carry out a first process for the detection of cloudiness in real time and thus be able to have a basis on which to work in the digital treatment of images from sky cameras. This new combination will make it possible to determine cloud cover scenarios more accurately and to classify clouds optimally. With more reliable cloud detection, the goal will be to improve the cloud prediction in the short term.

[2880] *Analysis of the Application of Different Forecasting Methods for Time Series in the Context of the Aeronautical Industry*

Antônio Augusto Rodrigues de Camargo (Aeronautics Institute of Technology - ITA) and Mauri Aparecido de Oliveira (Aeronautics Institute of Technology - ITA).

The aeronautical sector is a vital part of the Brazilian industrial landscape, contributing to the development of new technologies and production techniques with potential applications in other industries. However, due to its restricted nature, there are limited studies on implementing improvements in its systems, highlighting the need for attention in specific subareas of companies in this sector. One such area is the production planning department, especially the forecasting techniques applied in the supply chain, which play a crucial role in the operations of any company and are a determining factor in decision-making. The objective of this research is to compare the effectiveness of various time series forecasting methods, including classical statistical methods and neural networks. The study employs a real-time series that depicts the consumption of a specific material extensively used in the production line of a major Brazilian aircraft manufacturer. The proposed forecasting methods are applied, and the results are compared using three different evaluation metrics. The objective is to emphasize the significance of optimizing strategic planning within the industry and the potential savings that can be achieved by selecting the best forecast. In conclusion, the findings of this study can be used to enhance the efficiency of the supply chain and operations of companies in the aeronautical sector.

[2890] *Improved prediction of Norwegian consumption by adjusting for temporary fluctuations in dividend income*

Håvard Hungnes (Statistics Norway).

Household consumption, which accounts for about half of the GDP in mainland Norway, depends on various income components. Dividend income is one of these components, and this component has varied widely in recent years due to major changes in the taxation of dividend income. In 2006, dividend income accounted for 1 per cent of the household disposable income, while the share in the 4th quarter of 2021 was 19 percent. We show that in order to make good projections of household consumption - and thus GDP - it is therefore crucial to decompose dividend income into permanent dividend income and temporary dividend income, where the latter depends on adaptations to changes in the taxation of dividend income. We also show that the predictions of consumption based on a model with dividend-adjusted disposable income are better than predictions from a model with the standard measure of real disposable income.

[2918] *CONCEPTUAL MODEL OF SATISFACTION WITH MUNICIPAL HYGIENE CASE STUDY: CITY OF RIJEKA*

Drago Pupavac (Polytehnic of Rijeka), Marija Ivaniš (Faculty of Tourism and Hospitality Management, Opatija) and Renee Škulić (Faculty of Economics Rijeka).

This work aims to set up and test a conceptual model in the function of researching citizens' satisfaction with communal hygiene. The data were collected using the survey method in the city of Rijeka (n=403). The research results are based on the methods of descriptive and inferential statistics. The main hypothesic of this paper is that citizens' satisfaction with communal hygiene depends on 1) the waste collection system, 2) the quality of services of the communal company, and 3) the culture of residents in waste disposal. The main finding of this paper points to the conclusion that the change in the negative attitude towards waste and the increase in satisfaction with the communal hygiene of the city depends primarily on building a strong culture of residents in waste disposal.

[2950] *Garch-type Factor Model*

Chi Tim Ng (Hang Seng University of Hong Kong).

A new model is proposed for factor analysis of multivariate time series. The latent factors in the model are linked to observed time series through a deterministic relationship in a manner that is similar to the volatility process of the GARCH model. Mathematically-tractable quasi-likelihood is constructed for the proposed GARCH-type factor model, allowing efficient statistical inference even for high-dimensional time series incorporating non-Gaussian idiosyncratic components. Asymptotic theory for statistical inference of the proposed model is also developed. The applicability of the proposed model to real data is demonstrated through macroeconomic data and forward rate data of bonds. The factors extracted are then utilized to elucidate the risk premium of U.S. government bonds.

[2965] *Hints of Earlier and Other Creation: Unsupervised Machine Learning in Financial Time-Series Analysis*

James Chen (Michigan State University) and Charalampos Agiropoulos (University of Piraeus).

This study extends previous work applying unsupervised machine learning to commodity markets. Clustering Commodity Markets in Space and Time [1] examined returns and volatility in commodity markets. That paper supported the conventional ontology of commodity markets for precious metals, base metals, agricultural commodities, and crude oil and refined fuels. A Pattern New in Every Moment [2], used temporal clustering to identify critical periods in the trading of crude oil, gasoline, and diesel. This study combines the ontological methodology of Commodity Markets in Space and Time with the temporal clustering performed in A Pattern New in Every Moment. Ontological clustering, contingent upon the identification of structural breaks and other critical periods within financial time series, is this study's distinctive contribution. Conditional, time-variant ontological clustering should be applicable to any set of related time series, in finance and beyond.

References:

1. James Ming Chen, Mobeen Ur Rehman, and Xuan Vinh Vo (2021). Clustering commodity markets in space and time: Clarifying returns, volatility, and trading regimes through unsupervised machine learning. Resources Policy, 73: 102162. DOI: 10.1016/j.resourpol.2021.102162

2. James Ming Chen and Mobeen Ur Rehman (2021). A pattern new in every moment: THe temporal clustering of markets for crude oil, refined fuels, and other commodities. Energies, 14(19): 6099. DOI: 10.3390/en14196099

[2984] *Forecasting for circular operations: Net-demand characterisation and forecast accuracy measurement*

Thanos Goltsos (Cardiff Business School).

Environmental sustainability is a global priority as finite resources are being depleted at an unprecedented rate in human history. The linear economic model of make–use–dispose is leading to irreparable ecological damage and is no longer a viable option. The shift towards a Circular Economy (CE) and a make–use–reuse model is already underway but needs to supersede traditional practices (Ellen MacArthur Foundation, 2014). This has led to a considerable increase in CE research within the past decade, which is informing and uniting businesses, consumers, policy makers and academics to drive this necessary change (Stahel, 2016; Ellen MacArthur Foundation, 2022).

The transition to a CE is a complex undertaking that has major implications for operations management. Circular strategies and operations such as repair, remanufacturing, repurposing, and others, must now deal with extra uncertainties stemming from the core (used product) acquisition and transformation process (Guide and Jayaraman, 2000; Goltsos et al., 2019a). These operations rely upon accurate forecasts of demand, returns and net demand (demand minus returns) requirements.

Net demand (forecasting) departs from traditional demand (forecasting) on two fronts: a) its returns (forecast) constituent depends on past (and at times within-lead time) demand, and b) both net demand and its forecasts can take positive, negative or zero values. These issues have made net demand characterisation and forecasting challenging, and the measurement of its accuracy problematic (Goltsos et al., 2019b).

It is not surprising then that in the vast majority of relevant publications, net demand forecasting has been reduced to returns forecasting (often by way of assuming known demand). Any characterisation and accuracy measurement then are

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constrained to returns, blindsiding researchers and practitioners to only one of the sources of the uncertainty of net demand forecasting, and circular economic operations in general (ibid.). Take for example remanufacturing operations, where usually customer demand is partly satisfied by remanufacturing returns to an as-good-as-new state (Guide, 2000), and then any remaining net demand drives Original Equipment Manufacturer (OEM) replenishment. If we are not sure what distribution this net demand follows, nor can we appropriately judge the accuracy of its forecasts, how can we make sound inventory control related assumptions and ultimately orders?

This prevalent approach could then be described as 'indirect', where one forecasts demand and returns separately, and then take their difference as the net demand forecast, whereas the 'direct' approach would be to first construct the net demand time-series and then use that to produce forecasts (Shaker et al., 2014). This indirect approach might sidestep (or ignore) the issue of net demand characterisation, with thus far under searched inventory implications. At the same time the assessment of the resulting net demand forecast remains problematic. There exists then a dual open question for forecasting in the general circular economic operations context: what are appropriate candidate distributions for net demand, and how could we judge the forecasting accuracy of net demand forecasts? To the best of our knowledge, we are the first to attempt to address this dual shortcoming by a) characterising net demand distributions, and b) proposing appropriate accuracy measures that can deal with the intricacies of net demand forecasting. We propose appropriate candidate distributions of net demand, and test the behaviour of existing and proposed accuracy metrics. We do so via simulation, under a wide range of scenarios (of synthesised series), with properties based on empirical demand and returns timeseries, and comment on their appropriateness to aid and judge the forecasts' utility.

Net demand characterisation: The first step is to characterise the empirical and theoretically generated net demand timeseries, an area where at least in a supply chain context, to the best of our knowledge, almost no work has been conducted. An exception is the work of Kelle and Silver, 1989, which assumed normally distributed demand, returns, and therefore net demand. Beyond the above, an intuitively appealing candidate can be the Skellam distribution (Sellers, 2012; Ntzoufras et al., 2021), which is formed by the subtraction of two Poisson distributions. An issue that may arise is that there is an assumption of independence between the two Poisson distributions which, at first sight, is in direct violation since returns are dependent on past demands. However, combinations of long average length and high variance of the time-to-return distribution may yield series that may indeed be treated as independent. Also, of course, current demand and returns for a particular period may be uncorrelated or very weakly correlated. We test the above though simulation. We evaluate the above candidate distributions as well as others (e.g., the subtraction of two compound distributions), in terms of their accuracy.

Net demand forecast evaluation: Many of the standard accuracy measures are not suitable for net demand, because it may not be symmetrically distributed, and may contain zeroes. This means that net demand inherits many of the problems that have been identified for intermittent demand accuracy assessment. As summarised by Boylan and Syntetos (2021, Chapter 9), measures based on absolute errors are often unsuitable for asymmetrically distributed series. One of the promising accuracy measures for intermittent demand is the scaled mean squared error (Petropoulos and Kourentzes, 2015). However, requires adaptation for net demand because of the possibility of negative values. A similar issue will need to be addressed to enable the scaled Absolute Periods In Stock (sAPIS) measure (Wallström and Segerstedt, 2010; Kourentzes, 2014) to be used for net demand. In our research, we develop new measures that are appropriate for the assessment of net demand forecasting accuracy.

References

Boylan, J.E. and Syntetos, A.A., 2021. Intermittent Demand Forecasting: Context, Methods and Applications. John Wiley & Sons. Ellen MacArthur Foundation, 2014. Towards the circular economy: accelerating the scale-up across global supply chains. Technical report. https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-3-accelerating-the-scale-up-across-global [Accessed October 2022] Ellen MacArthur Foundation, 2022. Let's build a circular economy. https://ellenmacarthurfoundation.org/. [Accessed October 2022]. Goltsos, T.E., Ponte, B., Wang, S., Liu, Y., Naim, M.M. and Syntetos, A.A., 2019a. The boomerang returns? Accounting for the impact of uncertainties on the dynamics of remanufacturing systems. International Journal of Production Research, 57(23), pp.7361-7394. Goltsos, T.E., Syntetos, A.A., Glock, C.H. and Ioannou, G., 2021. Inventory–forecasting: Mind the gap. European Journal of Operational Research, 299(2), pp.387-419. Goltsos, T.E., Syntetos, A.A. and van der Laan, E., 2019b. Forecasting for remanufacturing: The effects of serialization. Journal of Operations Management, 65(5), pp.447-467. Guide Jr, V.D.R and Jayaraman, V., 2000. Product acquisition management: current industry practice and a proposed framework. International Journal of Production Research, 38(16), pp.3779-3800. Guide Jr, V.D.R., 2000. Production planning and control for remanufacturing: industry practice and research needs. Journal of operations Management, 18(4), pp.467-483. Kelle, P., Silver, E.A., 1989. Purchasing policy of new containers considering the random returns of previously issued containers. IIE Transactions, 21, pp.349-354. Kourentzes, N., 2014. On intermittent demand model optimisation and selection. International Journal of Production Economics, 156, pp.180-190. Koutsandreas, D., Spiliotis, E., Petropoulos, F. and Assimakopoulos, V., 2022. On

the selection of forecasting accuracy measures. Journal of the Operational Research Society, 73(5), pp.937-954. Ntzoufras, I., Palaskas, V. and Drikos, S., 2021. Bayesian models for prediction of the set-difference in volleyball. IMA Journal of Management Mathematics, 32(4), pp.491-518. Petropoulos, F. and Kourentzes, N., 2015. Forecast combinations for intermittent demand. Journal of the Operational Research Society, 66(6), pp.914-924. Sellers, K.F. 2012. A distribution describing differences in count data containing common dispersion levels. Advances and Applications in Statistical Sciences, 7(3), pp.35-46. Stahel, W. R. (2016). The circular economy. Nature, 531, pp. 435–438. Wallström, P. and Segerstedt, A., 2010. Evaluation of forecasting error measurements and techniques for intermittent demand. International Journal of Production Economics, 128(2), pp.625-636.

[2992] *Risk-adjusted Returns of Croatian Largest Manufacturers and Their Determinants*

Tomislava Pavic Kramaric (University of Split, University Department of Forensic Sciences, Split), Maja Pervan (University of Split, Faculty of Business, Economics and Tourism), Ivica Pervan (University of Split, Faculty of Business, Economics and Tourism, Split) and Ivan Pavic (University of Split).

Nowadays, firms operate in turbulent environments facing numerous challenges exposing their operations to various risks. Thus, the authors wanted to find out the key factors that are important in explaining firm performance considering the risks of the underlying business. The analysis is conducted using the sample of Croatian largest manufacturers that were active in the 2018 – 2021 period. Sharpe ratio, i.e. risk-adjusted return that takes into account profitability, its variability as well as risk-free rate is employed as a dependent variable. Furthermore, firm-specific variables such as firm size based on total revenues, capitalization, liquidi-ty presented with the current ratio, EBIT to sales ratio as well as publicly traded dummy served as independent variables. The conducted regression analysis re-vealed the significant determinants of risk-adjusted returns. Specifically, firm size, capitalization, liquidity, and EBIT-to-sales ratio positively affect the risk-adjusted returns of Croatian large and medium-sized manufacturers. Moreover, the publicly traded dummy also proved to be statistically significant in explaining firm performance whereas it takes a negative sign. These findings are robust to the modified measure of risk-adjusted return.

[2997] *EEG-Based Neural Synchrony Predicts Evaluative En-gagement with Music Videos*

Nikki Leeuwis (Tilburg University) and Tom van Bommel (Unravel Research).

The use of neuroimaging to predict individual and population-wide behav-iors, also known as neuroforecasting, has long been applied to estimate movie popularity. Only recently, Leeuwis et al. [1] aimed to predict aggre-gated popularity of music by analyzing EEG data collected during a listen-ing task. In particular, they applied the metric of neural synchronization, which is indicative of engagement, as a valid predictor of the listening be-havior of the population. However, the analysis did not incorporate the population's evaluative responses to the songs. To fill this void, this study explores whether neural synchrony can also be related to YouTube likes, dislikes and comments for the same songs more than two years later. In this way, we aimed to separate passive engagement (i.e., listening) from active engagement (evaluating). The results showed that neural synchrony was a significant predictor of the likes and comments on YouTube, even after con-trolling for explicit liking ratings from the lab study. In contrast, frontal al-pha asymmetry did not predict YouTube likes. Thus, engagement as repre-sented by neural synchronization can be a valuable tool for predicting ac-tive as well as passive engagement with entertainment products. This under-lines the value of neural similarity in predicting the impact of music and videos before their true effect in the crowd can be known.

[3011] *(A)symmetric pass-through from oil and natural gas prices to consumer price indices in European countries: some recent empirical evidence*

Ekaterini Tsouma (Centre of Planning and Economic Research (KEPE)) and Yannis Panagopoulos (Centre of Planning and Economic Research (KEPE)).

The aim of this paper is to investigate the pass-through from oil and natural gas prices to consumer price indices in selected European countries. Oil and natural gas belong to the most important fuel categories in Europe, with the course of their prices acquiring great significance for the European economy as a whole. We select up to eight individual consumer price index categories for each country under investigation, on the basis of their respective weights in the overall consumer price indices. The data sample includes the twelve early Euro Members, to reflect unified exchange rate and monetary policy regimes, for the total period under investigation. We use monthly data spanning the period from

January 2002 to the most recent period of time with available data. The sample period includes the episodes of both the COVID-19 pandemic and the recent energy crisis, related to the outbreak of the Ukraine war. In order to be able to account for potential asymmetries in the pass-through from oil and natural gas prices to consumer price indices, we apply a nonlinear autoregressive distributed lag (NARDL) model specification. This approach allows us to simultaneously test the short- and long-run nonlinearities through positive and negative partial sum decompositions of the explanatory variables (oil and natural gas prices). In addition, through asymmetric cumulative dynamic multipliers, the respective model selection enables us to capture the asymmetric adjustment patterns following positive and negative shocks to the explanatory variables. Our findings are expected to shed light on several important dimensions of the investigated pass-through mechanism. These are, in particular, long- and short-run asymmetries and the dynamic response to arising shocks. Among the provided evidence, emphasis should be put on potentially diverging pass-through results between countries. Such divergence may be related, among other things, to varying dependence on the two investigated fuel categories. Our conclusions may have significant implications for inflation developments in the considered European countries, but also for the conduct of European energy policy in the short to medium term. This becomes even more important with regard to the recent COVID-19 pandemic and the severe energy crisis triggered by the Ukraine war.

[3012] *Forecasting oil price with Bayesian dynamic finite mixture models*

Krzysztof Drachal (Faculty of Economic Sciences, University of Warsaw).

Bayesian dynamic mixture models (Nagy, I., Suzdaleva, E., 2013, Mixture estimation with state-space components and Markov model of switching, Applied Mathematical Modelling, 37, 9970-9984; Nagy, I., Suzdaleva, E., Karny, M., Mlynarova, T., 2011, Bayesian estimation of dynamic finite mixtures, International Journal of Adaptive Control and Signal Processing, 25, 765-787) can be successfully applied to forecasting prices of various commodities. On the other hand, this method has not been extensively explored in economics and finance yet. Although, some basic types of these model have already been applied to forecasting crude oil spot price (Drachal, K., 2021, Forecasting selected energy commodities prices with Bayesian dynamic finite mixtures, Energy Economics, 99, 105283). These models poses certain desirable features, like, ability to deal with model and variable uncertainties, incorporate time-varying relationships between explanatory variables and a response variable, and include a real-market players perspective, by on-line dynamic estimation (in contrary to static estimations, i.e., with fixed models parameters). The last property is obtained by recursive estimations, which combined with the additional first two properties, for other techniques usually result in tremendous computational obstacles. As the initial toy model of this research program, crude oil spot prices can serve. In particular, 10 potential explanatory variables are considered. Also, various robustness checks are performed. Bayesian dynamic mixture models are compared with other methods dealing with variable uncertainty and time-varying parameters, like, Dynamic Model Averaging. Moreover, time-varying parameters regression, ARIMA and the no-change forecast are taken as benchmark models. Forecast accuracy is evaluated with various methods: Diebold-Mariano test, Giacomini-Rossi fluctuation test and Model Confidence Set. Bayesian dynamic mixture models are found to outperform other analyzed methods, if forecast accuracy is considered. The research was funded by the grant of the National Science Centre, Poland, under the project number 2022/45/B/HS4/00510.

[3017] *Probability Density-Based Energy-Saving Recommendations for Household Refrigerating Appliances*

Francisco Rodríguez-Cuenca (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Eugenio Francisco Sánchez-Úbeda (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), José Portela (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Antonio Muñoz (Universidad Pontificia Comillas. Instituto de Investigación Tecnológica (IIT)), Victor Guizien (Advanced Analytics Market Iberia, Endesa Energía, Spain), Andrea Veiga Santiago (Advanced Analytics Market Iberia, Endesa Energía, Spain) and Alicia Mateo González (Advanced Analytics Market Iberia, Endesa Energía, Spain).

The power sector is a major contributor to anthropogenic global warming, responsible for 38% of total energy-related carbon dioxide emissions and 66% of carbon dioxide emission growth in 2018. In OECD member countries, the residential sector consumes a significant amount of electrical energy, with household refrigerating appliances alone accounting for 30-40% of the total consumption. To analyze the energy use of each domestic appliance, researchers have developed Appliance Level Energy Characterization (ALEC), a set of techniques that provide insights into individual energy consumption patterns. This study proposes a novel methodology that utilizes robust probability density estimation to detect refrigerators with high energy consumption and recommend tailored energy-saving measures. The methodology

considers two consumption features: base energy consumption (energy usage without human interaction) and relative energy consumption (energy usage influenced by human interaction). To assess the approach's effectiveness, the methodology was tested on a dataset of 30 different appliances from monitored homes, yielding positive results that support the robustness of the proposed method.

[3073] *Combine to compete: improving fiscal forecast accuracy over time*

Peter Claeys (Universidad Pontificia Comillas).

Budget forecasts have become increasingly important as a tool of fiscal management to influence expectations of bond markets and the public at large. The inherent difficulty in projecting macroeconomic variables – together with political bias – thwart the accuracy of budget forecasts. We improve accuracy by combining the forecasts of both private and public agencies for Italy over the period 1993-2012. A weighted combined forecast of the deficit/ ratio is superior to any single forecast. Deficits are hard to predict due to shifting economic conditions and political events. We test and compare predictive accuracy over time and although a weighted combined forecast is robust to breaks, there is no significant improvement over a simple RW model.

[3114] *MODELING THE ROAD ACCESIBILITY IN A FLOOD-PRONE AREA, IN ROMANIA*

Cristian Popescu (Technical University of Civil Engineering of Bucharest, Doctoral School) and Alina Barbulescu (Transilvania University of Brasov).

Hydrological phenomena have a negative impact on settlements, especially in areas that are located close to rivers, hilly or mountainous, with steep slopes, less vegetation, and high precipitation. The present study aims to the accessibility of the villages in the Vărbilău catchment (Romania) in the case of flood, based on field observations and GIS techniques.

[3116] *BERT for Solar Irradiance Time Series Imputation*

Llinet Benavides Cesar (Universidad Politécnica de Madrid), Miguel Ángel Manso Callejo (Universidad Politécnica de Madrid) and Calimanut-Ionut Cira (Universidad Politécnica de Madrid).

The availability of solar irradiance time series without missing data is the ideal scenario for researchers. This is not always possible for a variety of reasons, such as measurement errors, sampling gaps or other factors. Time series imputa-tion methods can be a solution to the lack of data. In this paper, we propose a so-lution based on Bidirectional Encoder Representations from Transformers (BERT) for irradiance time series imputation. A BERT model was trained from scratch, train it with the Masked Language Modeling (MLM) task. The quality of the imputation is evaluated according to the number of missing values and the position within the series. Experiments was conducted over a dataset with hun-dreds of stations, taken from meteorological stations distributed over two Spanish regions Galicia and Castile and León. In the evaluation process, an average coef-ficient of determination of 0.89% was obtained, although the best case was 0.95%.

[3148] *Role of Environmental Factors in Forming Birth Time Series*

Arzu Sardarli (First Nations University of Canada), Frank Trovato (University of Alberta) and Andrei Volodin (University of Regina).

The seasonal character of the incidence of births in European countries, the USA and Canada, has been observed by demographers and other scholars for a long time. Annual patterns of birth seasonality across such countries tend to be similar even though environmental and socio-cultural conditions can be quite different. In the Canadian context, the historical pattern of birth seasonality from the early part of the 20th century to the late 1980s has been studied, and a multitude of factors assumed to underlie the observed seasonal fertility variations have been classified. These factors can be subdivided into two groups: socio-cultural and environmental. Here we study the latter types of influences, hypothesizing that birth seasonality over the 20th century and the early years of the 21st century in Canada has correlated closely with seasonal fluctuations in temperature and amount of daylight across the seasons. We test this hypothesis within the geography of Canadian provinces. Our study improves on earlier works in this area by introducing a more accurate measure of the temperature effect. Usually, researchers use the value of temperature averaged over a territory (country, state or province). In the case of Canadian provinces, this would be problematic, as the temperature

difference between the south and north is quite significant and much greater than in most other countries. The spatial averaging of temperature over a large area would produce significant errors in measurement. Therefore, we first find the latitude and longitude of the population centre of each province and then use the temperature of this location in our analysis of birth seasonality across selected provinces. The set of monthly values of birth and the average temperature are considered as time series, and the classical time series analysis is applied to determine the correlation between the abovementioned variables considering the variety of functions (linear, quadratic, and cosine). Application of the cosine function allows us to estimate the phase shifts of time series of temperature and birth oscillations. The results of this analysis are verified by the multivariate regression analysis.

[3312] *Applications of Tobit Censored Exponential Smoothing to inventory management*

Juan R. Trapero (University of Castilla-La Mancha), Diego Pedregal (Universidad de Castilla-La Mancha) and Enrique Holgado (Universidad de Castilla-La Mancha).

Inventory management is essential for economic success of companies since it represents a significant part of their financial balance. Traditionally, inventory policies are designed to reach a compromise between customer service level and inventory costs. Stockouts represent one of the major issues that inventory management has to deal with. In general, such stockouts are modelled on the basis of two extreme cases: i) complete backordering or ii) complete lost-sales. In case that enough stock is available to meet demand, sales represent an unbiased demand estimate. Nonetheless, in the presence of stockouts and under a lost-sales inventory context, sales underestimate demand and, thus, sales forecasts are biased downwards. Such a demand underestimation will imply a lower inventory level and a lower customer service level.

In this work, we develop and use a general solution to the problem of demand forecasting based on sales data under a lost-sales inventory assumption by applying a Tobit Exponential Smoothing (TES) model. The results show that the proposed TES improves previous parametric ad-hoc approaches in terms of service level, inventory investment and lost-sales units when implementing a newsvendor stock policy approach.

[3363] *STATISTICAL ANALYSIS AND MODELING THE DISSIPATION OF VOLATILE ORGANIC COMPOUNDS FROM INDUSTRIAL EMISSIONS*

Sebastian-Barbu Barbes (Technical University of Civil Engineering Bucharest/Doctoral School of Civil Engineering), Alina Bărbulescu (Transilvania University of Brașov) and Lucica Barbes (Ovidius University of Constanta).

The study aims to investigate the dissipation of volatile organic compounds (VOCs) emitted from industrial sources using statistical analysis and modeling techniques. The research involves monitoring the concentration of VOCs in the ambient air around industrial sites and analyzing the data using various statistical methods, including regression analysis and time-series analysis. The study also involves developing mathematical models that can predict the dissipation of VOCs from industrial emissions based on various factors such as wind speed, temperature, and distance from the source. The results of this research are expected to provide valuable insights into the behavior of VOC emissions and assist in developing effective strategies for controlling and reducing industrial emissions.

[3377] *Unconventional Monetary Policy in India: Impact on Financial Markets*

Pami Dua (Delhi School of Economics) and Divya Tuteja (Indian Institute of Foreign Trade).

The objective of this study is to investigate the impact of the Reserve Bank of India's monetary policy actions, both conventional as well as unconventional, on the time-varying conditional correlation among financial markets in India. We employ the multivariate DCC-GARCH model in our work since it provides estimates of time- varying conditional correlation among the markets. In particular, the study focuses on the dynamic relationship between the equity, currency, short-term and medium-term money and government securities market segments. We utilize the Repo rate as a measure for conventional monetary policy. In order to capture the unconventional monetary policy tools, we use several specifications including announcement effect of Operation Twist, actual operations under Operation Twist, actual effects of Long Term Repo Operations (LTROs) and Targeted Long Term Repo Operations (TLTROs) and actual impact of Government Securities Acquisition (G-SAP) programme. Apart from these, we also include control variables in the analysis.We utilize weekly data from January 2010 till March 2022 for the analysis. Using a GARCH-DCC framework and several robustness tests, we investigate possible effects on the cross-market correlation dynamics. The empirical results

indicate that there exist significant announcement and actual effects of the unconventional monetary policy actions of RBI on the market correlations.

[3396] *Optimizing the Spatial-Temporal Extent of Environmental Factors in Forecasting El Niño and La Niña Using Recurrent Neural Network*

Jahnavi Jonnalagadda (George Mason University) and Mahdi Hashemi (George Mason University).

The El Niño-Southern Oscillation (ENSO) is caused by periodic fluctuations in sea surface temperature (SST) and overlying air pressure across the Equatorial Pacific region. ENSO has a global impact on weather patterns and can cause severe weather events, such as heat waves, floods, and droughts, which can affect regions far beyond the tropics. Therefore, forecasting these events with longer lead times is of great importance. This study utilizes Long-Short Term Memory (LSTM) to predict ENSO events in the coming year, based on environmental variables from previous years, including sea level pressure, zonal wind, meridional wind, and zonal wind flux. The spatial and temporal features of ENSO are derived by optimizing the extent of spatial and temporal window sizes of the environmental variables that impact ENSO. The study found that the accuracy of ENSO forecasts is sensitive to the extent of spatial and temporal windows of predictors. Specifically, increasing the temporal window size from 1 to 7 years and the spatial window from 0 to 17.7 geographical degrees resulted in classification accuracy ranging from 40.1% to 83% in the Central Pacific and 39.2% to 65% in the Eastern Pacific regions.

[3400] *Profiting from the Russian-Ukrainian War - Social Responsible Investment in the Context of Geoeconomics and Geopolitical Risk*

Lucia Morales (Technological University Dublin) and Daniel Rajmil (Universitat Oberta de Catalunya).

The international community is a silent witness to the devastation that is taking place in Ukraine and the impact of the conflict on the Russian and Ukrainian populations. The current situation raises serious concerns about the investor and business community and the ethics surrounding fossil fuel firms. The fossil fuel sector and its investors are taking advantage of the dramatic situation as they increase the profitability of their investment portfolios. The world's economic and political powers are a critical source of instability for economic and financial systems with implications for capital flows and investment decision-making. The interplay between political decisions and states' positioning of their economic agendas are driving forces of money flows and their allocation, raising significant concerns regarding ethical behaviour as profits are materialised due to severe damage to humans and the environment. The 2008 Global Economic and Financial Crisis revealed the strong connection between the international financial system and the real economy and the damaging effects of overlooking the connection. The implications for the real economy are substantial due to the growing complexity of the international political economy. Understanding geoeconomic and geopolitical risk emerges as critical for investors as they are sources of opportunities but also associated with risks. This paper explores the rationale behind social responsible investment in the context of the Russian-Ukranian war. The international community has responded by introducing economic sanctions to try and influence the armed conflict between the two countries. Some international businesses have interrupted their operations in Russia but quite quickly have signalled that they will return to the Russian market as soon as possible. Severe critics have emerged questioning investors' strategies seeking to benefit from the disruption created by the war, as fossil fuels firms and agricultural traders are cashing in on the ongoing conflict. This research paper explores volatility dynamics exhibited by fossil fuels with the support of an econometric framework focused on the analysis of volatility persistency and long memory processes. The well-known GARCH(p,q) and the FIGARCH (p,d,q) models will be considered to explore volatility patterns before and during the ongoing war. Machine learning algorithms are integrated as part of the modelling process with the aim of developing a comparative analysis between the selected GARCH models and their ability to capture the performance of the oil and gas market as a result of the conflict. The proposed study will provide critical insights framed in the context of the international political economy to shed some light on investors' social responsible behaviour and the opportunities to profit from the ongoing conflict between Russia and Ukraine.

[3418] *Demographic forecasting as a driver to rethink urban sustainability in the African context.*

Dr. Carlo Alberini (African Business School - Mohammed VI Polytechnic University).

Demographic forecasting has always represented a key dataset supporting the practice of urban planners. Cities development process is directly linked to the evolution of dwellers demographic time series. In 2011, for the first time in human history, more than half of the world population lived in urban areas. While developed countries move toward sustainable and resilient urban planning, developing countries are facing unprecedent challenges. By 2050 it's projected that two-thirds of the world population will live in urban areas, and Africa's urban population is expected to nearly triple to 1.34 billion. In approaching town planning in some African context, by adopting dwellers increase forecast as a driver, the meaning itself of "city" and "urban planning" require a paradigm shift. By 2040, 560 million people is expected to move into Sub-Saharan Cities. It is as if new urban areas containing the entire population of Morocco arise in African yearly. Is still possible to discuss about sustainability and resilience of African metro areas? In answering this question, this paper aims at supporting the need to adopt demographic forecasting as a pillar to support the urgent shift from urban planning to urban risk management. Urban practitioners and stakeholders must consider moving from planning formal city to driving informal urban growth, aiming at safeguarding natural environments, agricultural lands, and human lives.

[3500] *Quality Aware Conditional Generative Adversarial Networks for Precipitation Nowcasting*

Jahnavi Jonnalagadda (George Mason University) and Mahdi Hashemi (George Mason University).

Precipitation forecasting is crucial for emergency managers, aviation, and marine agencies to prepare for potential impacts. However, traditional radar echo extrapolation, which estimates future radar echoes based on the most recent radar readings, is limited in its ability to capture sudden changes in weather caused by convective systems. Deep learning models have emerged as an alternative to radar echo extrapolation and have shown promise in precipitation nowcasting. Yet, the quality of the forecasted radar images generated by these models deteriorates as the lead time increases, as measured by the Mean Squared Error (MSE) or Mean Absolute Error (MAE) loss functions. To improve the quality of the forecasted radar images, we propose using the Structural SIMilarity (SSIM) loss function as a regularization term for the Conditional Generative Adversarial Network (CGAN) objective function. Our experiments, conducted on satellite images from the year 2020 over the region (83°W-76.5°W, 33°S-40°S), demonstrate that the CGAN model trained with both L1 and SSIM loss functions outperforms CGAN models trained with only L1 or L2, or SSIM loss functions alone. We also compare the forecast accuracy of CGAN with other state-of-the-art models, such as U-Net and Persistence. Persistence assumes that rainfall remains constant for the next few hours, resulting in higher scores for shorter lead times (< 2 hours) for the critical success index (CSI), probability of detection (POD), and Heidke skill score (HSS). In contrast, CGAN trained with L1 and SSIM loss functions achieves higher CSI and POD for lead times > 2 hours and higher SSIM for all lead times, demonstrating the benefits of using SSIM as a loss function for precipitation forecasting, particularly for longer lead times.

[3501] *The prediction of body composition with extracted features from a chest-worn personal monitoring device*

Seung Min Lee (Seoul National University College of Medicine), Soon Bin Kwon (Seoul National University College of Medicine) and Hyung-Jin Yoon (Seoul National University College of Medicine).

The beneficial effects of data collected through wearable devices have been ob-served in providing innovative solutions in the healthcare domain, especially, re-lated to physical activity. Extracting new features from data and providing addi-tional knowledge with comprehensive and interesting summaries to users, is im-portant. The primary aims of this present study were (a) to extract new meaning-ful features from heart rates (HR) and energy expenditures (EE) data collected by a chest-worn device, and (b) to develop prediction models with these additional features to estimate body composition, a major indicator of physical fitness relat-ed to diet and exercise training. This study was conducted with a total of 304 sub-jects aged 20 to 65 years. HR and EE were collected using ActiHeart (Camntech Ltd., UK) in their free-living activity routine for at least 3 days. The outcomes, lean body mass (LBM) and fat mass (FM), were measured using multi-frequency bioelectrical impedance analysis (InBody 720). Linear regression, support vector regression (SVR), and lasso regression models were developed to estimate the outcomes with parameters such as age, sex, height, weight, body mass index (BMI), and features extracted from the exercise-like interval after signal pro-cessing. Models were developed and evaluated with a cross-validation technique using an 80 % split of the dataset for training/validation, while the remaining 20 % was used for testing. The addition of extracted features resulted in mean ab-solute percentage error (MAPE) reduced by 0.35%p (4.51% to 4.16%) in LBM and by 0.91%p (13.27% to 12.46%) in FM. The use of wearable-derived

features for estimating body composition may open up new possibilities for leveraging wearables in the pursuit of promoting health and wellness.

[3505] *Offshore Wind Power Forecasting Based on WPD and optimized deep learning methods*

Shahram Hanifi (University of Glasgow), Saeid Lotfian (Strathclyde university), Hossein Zare-Behtash (University of Glasgow) and Andrea Cammarano (University of Glasgow).

Accurate and efficient forecasting of wind power is of great importance for the penetration increment of wind power into the power grid and to secure a stable power system. After evaluating different approaches to increase the accuracy of prediction models, a novel hybrid method is developed based on the application of wavelet packet decomposition, deep learning models tunned by the sequential model-based optimization algorithm. Wind power time series data of an offshore wind turbine in Scotland is decomposed into different subseries of different frequencies so that deep learning models can better learn short- and long-term dependencies. Then the prediction for each subseries was performed separately by tunned models and the final prediction was obtained by aggregating the results. A comparison of the forecasting results of the proposed model and other involved models proves the superior prediction accuracy of the proposed forecasting model. In addition, the results show that utilizing advanced optimization methods instead of common hyperparameter selection methods such as grid search or random search improves efficiency by reducing the required time to tune the deep learning neural networks.

[3535] *Forecasting of signals by forecasting linear recurrence relations*

Nina Golyandina (St.Petersburg State University) and Egor Shapoval (St.Petersburg State University).

Forecasting of a signal that locally satisfies linear recurrence relations (LRRs) with slowly changing coefficients is considered. A method, which estimates the local LRRs by the subspace-based method, predicts their coefficients and constructs a forecast by the LRR with the predicted coefficients, is proposed. This method is implemented for time series, which have the form of a noisy sum of sine waves with modulated frequencies. Linear and sinusoidal frequency modulations are considered. The application of the algorithm is demonstrated by numerical examples.

[3582] *SUPERVISED CLASSIFICATION OF SPATIO-TEMPORAL CHANGE DETECTION MAPS*

Maia de Souza Ugarte (University of Campinas), Matthieu Gallet (LISTIC, Université Savoie Mont-Blanc), Abdourrahmane Atto (LISTIC, Université Savoie Mont-Blanc) and Aluísio de Souza Pinheiro (University of Campinas).

Synthetic Aperture Radars (SAR) operate independently of the weather conditions and light presence, in contrast to optical satellites, being a reliable source of repeated land monitoring. This type of satellite makes it a rich tool for the study of spatio- temporal transformations of territory. Such application brings benefits in the context of urban monitoring [1], deforestation [2], crop monitoring [3], sea ice tracking [4]. Fast and easy accessibility of SAR images from all around the globe has been made available thanks to the Sentinel-1 mission. Additionally, it has a 6 to 12 day repeat cycle orbit that enables the acquisition of an image time series of a specified area. These satellites are a good compromise between spatial (10m per pixel) and temporal resolution, operating in polarization VV and VH in C band, making them an interesting solution for monitoring change. Change detection has been widely studied, with various inputs, leading mainly to binary maps indicating change and non- change of the observed areas. The main challenges of this tool applied to SAR imagery lies in the management of the presence of a multiplicative noise: the speckle. There are many works using wavelet decomposition to filter the speckle [5] ,[6] and subsequently to carry out a study of the changes [7] [8]. Another difficulty resides in the capacity of a model to differentiate the different types of changes, by clustering or classification [9]. Indeed, these changes, of different nature, can be spatial, temporal or both, and their respective responses require a multi-scale [10] vision when processing different satellite images covering large and varied areas. In this paper we propose to adapt the recent unsupervised change detection method Wavelet Energy Correlation Screening (WECS) proposed by [11] to classify the output as proposed in [12]. To do so, we adapt the method to take into account the local spatio-temporal correlation of the pixels in addition to the global one proposed by WECS . The result of this new map is evaluated at the scale of the island of Reunion thanks to the ground truth obtained in [13]. The classification is finally obtained by using a K-Nearest Neighbors (KNN) on these new maps

[3597] *Nexus between Economic Growth and Health Indicators: Evidence from Pakistan*

Nadeem Malik (National University of Modern Languages, Islamabad) and Reema Gulzar (National University of Modern Languages, Islamabad).

The goal of this article is to look at how various health indices affect Pakistan's economic growth. Error Correction and co-integration methods were used on Pakistan time series data from 1990 to 2022. Long-run, there is a significant relationship between per capita GDP and health indicators, which are significantly affecting per-capita GDP. According to the short run, health indicators have no meaningful influence on per-capita GDP. While indicators of health have a considerable long-run influence in economic growth. It implies that the influence of health indicators can only impact in the long run. The study's main result suggests financial gain, through growing and raising the stock of healthy human capital, particularly if present stocks are at a low level. Improved health has a two-way interaction with the economic process. This increased financial gain is spent on human capital investment can result in higher per capita growth. The goal of this research is to examine the short-run and long-term temporal connections between health and per capita GDP using mistreatment Co-integration and Error Correction. Long-term health and economic process studies would be extremely valuable in determining the achievable magnitudes of the entire cumulative effects of health on economic process. Two key hypotheses would be examined; the first would be that 'health influences economic growth' might be a long-standing temporal development. Second, what role do health output and input factors play in per capita GDP growth?

[3634] *Extreme Characteristics of Stochastic Non-Stationary Duffing Oscillators*

Samuel Edwards (Naval Surface Warfare Center - Carderock Division), Matthew Collette (University of Michigan) and Armin Troesch (University of michigan).

Unexpected responses in dynamic systems can lead to catastrophic failures. Without full knowledge of the system, it is impossible to know if all of the dynamics have been captured or considered. Furthermore, a large number of Monte Carlo simulations may be time prohibitive when looking at extreme behavior. It follows that engineers designing systems that contain unknown dynamical properties such as a domain of attraction orders of magnitude larger than the ordinary motion would benefit from a method that could identify the presence of these very dynamics. In this paper, a method is developed and tested to identify rare dynamics of non-linear systems.

The method discussed in this paper is called the Matched Upcrossing Equivalent Linear System (MUELS) linearization method. The MUELS method is a linearization scheme that searches for linear systems that have the same zero-upcrossing rate as the non-linear system of interest. After identifying a contour of linear systems, the transfer function from said linear systems and input forcing spectrum are input into the Design Loads Generator (DLG). The DLG is a tool that generates extreme realizations of a Gaussian process with a Gaussian input at the Target Extreme Value (TEV) of interest. The TEV is simply an indicator of how the magnitude of the expected maximum increases with the number of observed trials, n, is of the form: $TEV = \sqrt{2\log(n)}$. It can be noted that for a Gaussian process, the most probable maximum value in n cycles is the product of the TEV and the rms of the process, which is also the standard deviation in Gaussian processes. The DLG also produces the corresponding input time series that lead to the extreme realizations which can then be used as input into the non-linear system of interest. These input time series can become candidates as input time series that lead to extreme events in the non-linear system of interest.

In this paper, the MUELS method is applied to a series of Duffing oscillators of varying stationarity, characterized by brief excursions into domains of much larger oscillation, to test the non-linear limits of the MUELS method as well as the ability of the MUELS method to uncover rare dynamics. These systems are then input into the Design Loads Generator (DLG) to produce an ensemble of input time series that lead to extreme linear realizations, which are then used as input into the non-linear system of interest. The MUELS method results are compared to Monte Carlo simulations in various ways. First, the time series maxima pdfs are compared in both level of bi-modality as well as peak location(s). Second, the actual time series near the extreme (or conditional extreme) events are compared. It was found that the MUELS method recovers extreme behavior with relative success, seeing more accurate results for more stationary systems. The current work suggests that improvements to return period estimation and equivalent linear system parameter fidelity could produce even more accurate results.

[3701] *Recurrent Forecasting in Singular Spectrum Decomposition*

Maryam Movahedifar (Institute for Statistics, University of Bremen), Hossein Hassani (Department of Business and Management, Webster Vienna Private University) and Mahdi Kalantari (Department of Statistics, Payame Noor University).

Singular Spectrum Analysis (SSA) is a powerful and non-parametric technique in time series and has been developed and applied to many practical problems. This method does not require any statistical assumptions such as stationary or linearity of the time series, which are unlikely to hold in the real world. Basic SSA has the ability to filter and forecast time series that can be operated as univariate or multivariate. In short, the SSA technique initially filters a time series and then reconstructs a less-noisy series, which is used for forecasting new data points. Generally speaking, Singular Spectrum Analysis (SSA) is a time series forecasting method that uses a decomposition technique to separate the underlying components of a time series. The basic steps of SSA for time series forecasting are as follows: 1. Data Preparation: The time series data is prepared by detrending and deseasonalizing it, if necessary, to remove any non-stationary components. 2. Trajectory Matrix: A trajectory matrix is constructed by lagging the original time series data and stacking the lagged versions on top of each other. 3. Singular Value Decomposition (SVD): The trajectory matrix is then decomposed using SVD, which results in a set of eigenvectors (component time series) and eigenvalues. 4. Eigenvectors Selection: The eigenvectors with the highest eigenvalues are selected to reconstruct the original time series. 5. Reconstruction: The selected eigenvectors are used to reconstruct the original time series by multiplying them by the corresponding eigenvalues and summing the results. 6. Forecasting: The reconstructed time series is used for forecasting by using the last few values as the starting point for the forecast. The purpose of this paper is to evaluate and compare two forecasting algorithms based on SSA and new Singular Spectrum Decomposition (SSD) methods over time-frequency data sets. SSD is a modern iterative based on the SSA decomposition method in which the selection of the embedding dimension and the choice of the principal components for reconstruction and forecasting of a particular component series have been made fully data-driven. In the SSA-based method, the number of observations required to construct the trajectory matrix is variable. While in the trajectory matrix based on the SSD method, the number of repetitions of observations in the trajectory matrix is equal to L. Here, L determines the number of rows in the trajectory matrix and is called window length. Assuming $L \leq N/2$, to retain more information, the larger L is the better, and for the statistical confidence one needs to achieve, the smaller L is the better. To choose the window length, L must be large enough $(L \sim N/2)$ and if we want to extract a periodic component with a certain period, the window length that is divisible by the period provides a better resolution. In the case of time series with different frequency domains, for instance, a harmonic time series such that the first half of the signal starts at a low frequency, and an alternating high-frequency oscillation forms the second half of the signal, it may be difficult to extract the oscillatory components using the SSA method, because an appropriate window length must be set at each step. In the SSD method, the selection of the window length or embedding dimension $(L \leq N/2)$ to build the trajectory matrix is set as a linear function of the inverse of the dominant frequency of the data, i.e., $1/f\_max$. All this ensures SSD is an adjustable decomposition method, with the advantage of increasing its oscillatory content and providing useful properties to reduce residual energy. Therefore, it can be expected that SSD as an improved version of SSA can achieve more reliable results for predicting new data points in the time series with different frequencies. The two forecasting variations in SSA are known as Vector SSA (V-SSA) and Recurrent SSA (R-SSA). The efficiency of V-SSA has been shown in many instances. Recognizing the need to improve the R-SSA forecasting approach, this paper aims to develop an innovative recurrent forecasting algorithm named R-SSD, which we expect would generate more accurate forecasting results. In this regard, the proposed R-SSD method generates its coefficients from a modified trajectory matrix based on the SSD method. This modified approach is called Recurrent Singular Spectrum Decomposition (R-SSD), which results in an energy reduction of the residuals. Simulation and real case studies are conducted to investigate the properties of the proposed method, and then its performance is compared with the R-SSA method. The results indicate that the R-SSD forecasting method yields more accurate results than the basic R-SSA forecasting method in terms of Ratio Root Mean Squared Errors (RRMSE) and Ratio Mean Absolute Errors (RMAE) criteria. In addition, obtained results from the Kolmogorov-Smirnov Predictive accuracy (KSPA) test indicate significant accuracy gains by using the R-SSD method compared to the competing R-SSA method. The KSPA test is applied to measure the maximum distance between the empirical cumulative distribution functions (CDFs) of recurrent prediction errors of R-SSD and R-SSA methods and to determine whether forecasts with a lower error lead to stochastically less error. In addition, the findings from the non-parametric Wilcoxon test show that the proposed R-SSD technique outperforms the R-SSA technique in filtering and forecasting new data points.

[3720] *The Inner Struggles of Transitioning to Democracy and Democratic Consolidation in Sudan*

Andrew Tchie (NUPI).

The use of transitional agreements as a model of resolving differences between the state, armed and non-state armed actors across the African continent appears to be on the rise. However, many of these transitional agreements tend to be stagnant and neglect to deal with grievances, causes of political unrest, and the root causes of conflicts and provide sustainable paths to democracy that transitional governments agree to navigate. Indeed, transitional agreements often fail to consider path dependencies of the previous regimes, neglecting to offer transitional governments with adaptive stabilisation strategies that can help to circumvent existing structures set up by past regimes. Drawing on the case study of the civilian-led Transitional Government of Sudan (TGS) from April 11, 2019, to October 25, 2021, and an original dataset, this paper argues that the TGS policies were not designed to dismantle the existing state structure lacked an adaptive people-focused approach and sustainable strategic thinking to reach the desired stipulations in the agreement. The analysis finds that TGS's political rhetoric did not align with political realities, primarily due to the inability of the TGS to dismantle existing power structures under previous regimes. As a result, the paper argues for better provisions and support utilising adaptive stabilisation strategies to support incoming transitional governments in African states trying to emerge from autocracy or dictatorship during transitional periods to democracy.

[3723] *Development of methodology for the Evaluation of Solar Energy through hybrid models for the energy sector*

Georgina Lizeth González (Universidad Autonoma del Estado de Morelos), Jesus Cerezo (Universidad Autonoma del Estado de Morelos) and Guillermo Santamaria (INEEL).

Currently, economic development has increased disproportionately caused by the increase in the global energy demand, putting the supply and demand of it at risk. Renewable energies represent an alternative to solve this problem; however, these resources have some limitations due to their availability. The objective of this work is to develop a methodology for the forecast of electrical energy through the solar resource through hybrid models, using clear-sky, statistical and artificial intelligence models, through multilayer neural networks with a forecast horizon of 24 hours ahead. The case study was based on a photovoltaic array located in Ashland, Oregon. The study was divided into five stages Stage one consisted in the acquisition of a time series with a horizon resolution of every five minutes in a period of two years and nine months, in parallel, a clear sky model was developed in which its configuration consisted of having the solar irradiance forecast and calculate the electric power from it. Said model allowed to have a point of reference on the behavior of the time series. The second stage consisted of carrying out an Autoregressive Integrated Moving Average (SARIMA) model with a 24-hour forward seasonality, taking four autoregressive past observations and three moving averages without applying time series differences. The third stage consisted of mapping the observations in different phases of space by means of the Time Delay Coordinate (TDC), calculating the delay time and the dimensions for a better description of the behavior of the time series, in addition to generating more information that the neural network can receive. The fourth stage consisted of joining the forecasts of the clear sky, SARIMA and TDC models in a database, providing more input information to the multilayer neural network. In the fifth stage, each of the models was evaluated according to the mean square error, the mean absolute error and the degree of precision of the models. The results showed that the clear sky model had an accuracy degree of 86%, while the SARIMA model was 94%, however, the multilayer neural network that was supplied from the aforementioned models and including TDC had an accuracy degree of 97.6%, significantly improving its accuracy. The implementation of hybrid models is a tool that allows improving the forecasts of electrical energy from the solar resource accurately and quickly.

[3744] *Multivariable NARX based Neural Networks Models for Short-term Water Level Forecasting*

Jackson Renteria-Mena (Universidad Tecnologica del Choco), Douglas Plaza (Escuela Politecnica del Litoral) and Eduardo Giraldo (Universidad Tecnológica de Pereira).

In this work is presented a novel application for multivariable forecasting applied to hydrological variables and based on a multivariable NARX model. The proposed approach is designed for two hydrological stations located at the Atrato River in Colombia where the variables water level, water flow and water precipitations are correlated by using the NARX model based on a neural network structure. The structure of the NARX based neural network is designed in order to consider the complex dynamics of hydrological variables and their corresponding cross-correlations. A short-term water level forecasting is designed based in the NARX model to be used as an early warning flood system. The validation of the proposed approach is performed by comparing the estimation error with an ARX dynamic model. As a result, it is shown that a NARX model structure is more suitable for water level forecasting than simplified structures.

[3755] *An Auto Encoder and Generative Adversarial Network Model for Time Series Data Classification*

Junpeng Bao (Xi'an Jiaotong University), Zihang Liu (Xi'an Jiaotong University), Junqing Wang (Xi'an Jiaotong University) and Yanhua Li (Beijing Institute of Control Engineering).

Time series data is a kind of most common big data that is always created by plenty of real time applications in the fields of medicine health, traffic management, industrial monitoring, financial supervision and sensor networks. Time Series Classification (TSC), which means to recognize patterns in time series data, is a fundamental task for these applications. However, it is still hard for a specific model to precisely recognize any patterns from any time series data. In fact, a deep learning model's generalization ability is still a big problem. This paper presents a hybrid generative network that achieves higher accuracy on more time series data than the state of art model. Auto Encoder (AE) and Generative Adversarial Networks (GAN) are two valuable generative learning models with different learning principles. We combine these two models together in order to fuse the AE's ability of feature compression and the GAN's ability of data generalization. Thus, the paper proposes an Auto Encoder and Generative Adversarial Network Model (AESGAN) to improve the classification accuracy of time series datasets. In the AEGAN model, the GAN's discriminator is strengthened by the auto encoder, which can efficiently extract features of various time series, and a novel loss function is designed for it. We compare the AEGAN with other excellent TSC models on 84 UCR datasets. The experimental results show that the AESGAN is superior to the state of art models in terms of classification generalization and accuracy.

[3787] *Automata Based Multivariate Time Series Analysis for Anomaly Detection over Sliding Time Windows*

Arnold Hien (IMT Atlantique, LS2N-CNRS), Nicolas Beldiceanu (IMT Atlantique, LS2N-CNRS), Claude-Guy Quimper (Laval University) and María-Isabel Restrepo (IMT Atlantique, LS2N-CNRS).

We describe an optimal linear time complexity method for extracting patterns from sliding windows of multivariate time series that depends only on the length of the time series. The method is implemented as an open source Java library and is used to detect anomalies in multivariate time series.

[3791] *Ecological Forecasting*

Yiqi Luo (Cornell University).

The capability to forecast the impacts of environmental change on our living environment and natural resources is critical to decision making in a world where the past is no longer a clear guide to the future. We are living in a period marked by rapid climate change, profound alteration of biogeochemical cycles, unsustainable depletion of natural resources, proliferation of exotic species and infectious disease, and deterioration of air and water quality. Human populations are increasing at an alarming rate, and society is dependent on the extraction and utilization of natural resources to support regional and global economies. Predictable and increasing supplies of energy, food, fiber, freshwater, and clean air are necessary to maintain healthy human societies. To effectively mitigate and adapt to climate change, we need to forecast future states of ecosystems and then to assess resilience and, potentially, collapse of ecosystem services.

We have developed the capacity of ecological forecasting regarding terrestrial carbon cycle in response to global change. We have examined the fundamental properties of terrestrial carbon cycle and found that almost all the carbon cycle models can be unified by a matrix equation even though the carbon cycle models have different levels of complexity. The matrix equation displays one of the key properties of terrestrial carbon dynamics, which is the convergence toward equilibrium over time, even if external forcing and disturbances often push the carbon cycle to be in disequilibrium. Overall, many processes of the terrestrial carbon cycle are intrinsically predictable. For these processes, forecasting is expected to be highly achievable. However, the indirect effects of climate change on terrestrial carbon cycle become less predictable, especially those which lead to ecosystem state changes. In addition, individual disturbance events usually occur stochastically even within a stationary disturbance regime. For such processes, forecasting is expected to be more uncertain.

We have developed a workflow system for near-time ecological forecasting. The system is Ecological Platform for Assimilating Data (EcoPAD) into models. EcoPAD is a software system that links sensor networks to ecological forecasting. It integrates eco-informatics, web-technology, ecological models, data assimilation techniques, and visualization. Data and models are integrated through a data assimilation system before the trained models are used for forecasting,

optimization of measurement plans, and uncertainty analysis. The data to be integrated can come from the real-time sensor networks or from spreadsheets with records of hand measurement. EcoPAD offers three options, which are simulation, data assimilation and forecast, in response to a request from users. Once one user made a request, EcoPAD can execute the task automatically to generate results. The generated results can be visualized in real-time as well. Thus, EcoPAD is an interactive software system for researchers to automatically execute model simulation, data assimilation, and ecological forecasting in real- or near-time.

We have applied EcoPAD to the SPRUCE experimental site located in Northern Minnesota, USA. SPRUCE is a whole ecosystem warming and CO_2 enrichment project. It has five levels of temperature treatments and two levels of CO_2 concentrations. The experiment follows a gradient design with five chambers for five levels of temperature treatments at ambient CO_2 concentration and five chambers at elevated CO_2 concentration. The project is very well equipped with lots of real-time sensors and involves more than 100 scientists who make many kinds of measurements. The real-time sensors send data to data servers. Data servers also store the data from hand measurements. EcoPAD automatically ingests data from data servers through a web app server for data assimilation and forecasting. The forecast results are automatically sent to two sites, one at the SPRUCE site and one at our lab website, for visualization. EcoPAD has done ecological forecasting automatically at midnight on Saturday every week since June 2016.

The forecasting variables include snow cover, soil thermal dynamics, and frozen depth; many carbon cycle variables, such as gross primary production, net primary production, net ecosystem production, and ecosystem respiration; and methane flux and pathways.

[3843] *Increasing the Performance and Plausibility of Machine Learning via Data Analysis Techniques*

Silas Aaron Selzer (Technische Universität Ilmenau), Fabian Bauer (Technische Universität Ilmenau) and Peter Bretschneider (Technische Universität Ilmenau).

The identification of significant input variables is crucial for the quality of machine learning models, since the models can only be as good as the representative quality of the data provided. In this paper, different filter methods are compared as a subset of data analysis techniques for feature selection. Using real data from the power engineering field, the strengths of data analysis as a pre-processing step are demonstrated and the effectiveness of different filter methods are compared. The data analysis techniques not only increase the performance of machine learning models, but also their plausibility by identifying important input variables and reducing model complexity, resulting in more trustworthy and reliable models.

[3867] *Noise in GPS-DORIS co-located station position time series*

Sofiane Khelifa (Centre of Space Techniques / Algerian Space Agency).

The noise in the position time series of GPS (Global Positioning System) and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) co-located stations is analyzed by means of the spectral analysis to qualify its spectrum and the wavelet threshold denoising method to quantify its level. The data used are the residual coordinate time series of 27 well observed GPS-DORIS co-located stations, aligned to ITRF2014, expressed into a topocentric (North, East, Up) coordinate frame and included data from 1999 to 2021. The estimation of the spectral indices of the power spectrum of the analyzed time series is based on the Welch method. The spectral index values show that the noise spectrum in the three components (North, East and Up) is mainly qualified as flicker noise for GPS and white noise for DORIS. The determination of the noise level was based on the thresholding of the wavelet transform coefficients, using the universal threshold method in the case of white noise and the hybrid threshold method in the case of flicker noise. The average noise level in respectively, North, East and Up components is about of 1.2 mm, 1.2 mm and 4.1 mm for GPS and, 4.8 mm, 7.8 mm and 5.4 mm for DORIS. The DORIS noise level is higher for tropical stations (± 23° latitude) and lower for high latitude stations. Furthermore, this paper has shown that the DORIS solution submitted for ITRF2020 realization was improved in terms of noise level compared to that submitted for ITRF2014 realization. However, unlike the analysis of noise by Allan variance method and the maximum likelihood estimation, the analysis methodology presented in this paper is fast and direct without a priori assumptions about the properties of the analyzed time series.

[3871] *STATISTICAL ANALYSIS AND MODELING OF POLLUTANTS SERIES IN THE REGION OF BRASOV, ROMANIA*

Maftei Carmen (Transilvania University of Brasov) and Alina Barbulescu (Transilvania University of Brasov).

In the context of increasing atmospheric pollution worldwide, especially in high urban agglomerations, the article investigates the NOx and PM10 series to estimate the level of contamination in Brasov, one of the most famous resorts from Romania. The outliers' existence is assessed by alternative methods, and the periodicity/non-periodicity is emphasized. Models are fitted to the extreme series.

[3892] *A Novel Unconstrained Geometric BINAR(1) Model.*

Yuvraj Sunecher (UNIVERSITY OF TECHNOLOGY MAURITIUS) and Naushad Mamode Khan (UNIVERSITY OF MAURITIUS).

Modelling the non-stationary unconstrained bivariate integervalued autoregressive of order 1 (NSUBINAR(1)) model is challenging due to the complex cross-correlation relationship between the counting series. Hence, this paper introduces a novel non-stationary unconstrained BINAR(1) with Geometric marginals (NSUBINAR(1)GEOM) based on the assumption that the counting series are both influenced by the same time-dependent explanatory variables. The Generalized QuasiLikelihood (GQL) estimation method is used to estimate the regression and dependence parameters and is compared with other established estimation methods: Generalized Method of Moments (GMM) and Generalized Least Squares (GLS). Monte Carlo simulations and an application to a real life accident series data are presented.

[3922] *Score-Driven Model for Dynamic Rankings: Methodology, Implementation, and Applications*

Vladimír Holý (Prague University of Economics and Business).

Time-varying rankings represent a unique data type that has often been overlooked in the literature. We present a time series model based on the Plackett-Luce distribution with dynamic worth parameters. The dynamics are driven by the autoregressive term and the conditional score. The model therefore falls to the class of generalized autoregressive score (GAS) models, also known as dynamic conditional score (DCS) models. We estimate the model by the maximum likelihood method. Our approach provides a flexible tool for modeling of time-varying rankings, similarly to the ARMA model in the case of continuous variables.

Our model is implemented in recently released R package gasmodel. It offers functionality to estimate, forecast, and simulate score-driven models based on various distributions with any time-varying parameters, including the Plackett-Luce distribution. It also allows to include exogeneous variables in the dynamics and specify the model in the fashion of regression with dynamic errors, which is suitable in our case.

We present three applications of our approach. First, we model annual results of Ice Hockey World Championships. Second, we model annual rankings of the big three german car manufacturers according to market capitalization. Third, we model annual rankings of European countries according to efficiency of research and development obtained by data envelopment analysis.

[4024] *Urban Heat Island Intensity Prediction in the Context of Heat Waves: An Evaluation of Model Performance*

Aner Martinez-Soto (Universidad de La Frontera) and Alexander Zipf (Heidelberg University).

Various techniques have been developed to determine the intensity of urban heat islands. How-ever, in heat wave contexts (more than 3 days with temperatures above 30°C), models tend to underestimate the intensities that can be empirically measured. This study proposes a model based on hourly time series to predict the intensity of heat islands in heat wave contexts. The model is fed and validated with empirical data obtained from the National Monitoring Network of Chile in the city of Temuco. The results show a high correlation (r > 0.91) between the model's results and the monitoring data. Additionally, the possibility of transferability of the modeling approach to other cities with different climatic characteristics is discussed.

[4046] *Combining Forecasts of Time Series with Complex Seasonality using LSTM-based Meta-Learning*

Grzegorz Dudek (Czestochowa University of Technology).

In this paper, we propose a method for combining forecasts generated by different models based on long short-term memory (LSTM) ensemble learning. While typical approaches for combining forecasts involve simple averaging or linear combination of individual forecasts, machine learning techniques enable more sophisticated methods of combining forecasts through meta-learning, leading to improved forecasting accuracy. LSTM's recurrent architecture and internal states offer enhanced possibilities for combining forecasts by incorporating additional information from the recent past. We define various meta-learning variants for seasonal time series and evaluate the LSTM meta-learner on multiple forecasting problems, demonstrating its superior performance compared to simple averaging and linear regression.

[4095] *Combination of Probabilistic Predictions for Wind Energy Production*

Shadi Nouhitehrani (Universidad Politécnica de Madrid), Jesús Juan (Universidad Politécnica de Madrid) and Eduardo Caro (Universidad Politécnica de Madrid).

The integration of wind power into electric power systems presents challenges due to the variability of wind power production. Reliable prediction models that accurately forecast wind power production for the coming hours and days are necessary for efficient management of the system. Rather than relying on a single prediction model, combining multiple predictions can improve forecast accuracy. This can reduce both biases and measurement errors and improve system reliability. Wind power plays a crucial role in the Spanish electricity system, accounting for 25% of the total installed capacity. This study presents an analysis of the accuracy of three different wind power production forecasting models and a practical method to combine these predictions in order to enhance the accuracy of the forecasts and improve the reliability of the electric power system. The models used in the study are based on meteorological information and physical and statistical models, and are employed by the Spanish Peninsular System Operator. The proposed combination approach, the Bernstein Online Aggregation (BOA) method, consistently reduces the prediction errors for horizons ranging from one to forty-eight hours. Additionally, an original procedure is proposed to obtain probabilistic predictions from the prediction intervals of the individual models. These predictions, when combined, provide efficient coverage of the predicted power production and meet the requirements of the energy system.

[4130] *Calculating Effectiveness of Covid-19 Non-Pharmaceutical Interventions by Interrupted Time Series Analysis with Clustering-based Counterfactual Country*

Fatemeh Navazi (McMaster University), Yufei Yuan (DeGroote School of Business, McMaster University) and Norm Archer (DeGroote School of Business, McMaster University).

This is the abstract submission, please see the attached file.

[4131] *Comparative analysis of recommendations issued by stockbrokers and oriented fuzzy numbers in case of DAX companies*

Aleksandra Wójcicka-Wójtowicz (Poznań University of Economics and Business) and Anna Łyczkowska-Hanćkowiak (WSB University in Poznań).

Investors often use their own knowledge, experience and intuition in case of stock investments. However, they often compare their premonitions or choices with the recommendations of specialists to verify their choices. The recommendations usually come in a form of a natural language label such as: buy, sell, accumulate, reduce etc.

In this paper we propose the approach of comparing the efficiency of recommendations established by trapezoidal oriented fuzzy numbers (including information uncertainty and imprecision) with those issued by experts (stockbrokers). The analyzed companies are included in DAX index of German Stock Exchange.

In portfolio fuzzy approach we use such elements as expected fuzzy discount factor which results in imprecise present value. In the proposed comparative analysis we use an empirical case study.

[4189] *Usage of portfolio replication in non-life insurance*

Petr Vejmělka (Faculty of Mathematics and Physics, Charles University) and Tomáš Cipra (Faculty of Mathematics and Physics, Charles University).

In this contribution, present an alternative to the broadly used bootstrap method in non-life insurance reserving based on state-space modeling of time series. The bootstrap method is useful when an insurance company wants to analyze the distribution of the reserves. However, the actual application of this method can be difficult. When the original portfolio of insurance claims is reasonably replicated, one can easily estimate the distribution of the reserve. Therefore, in this article, we apply the replication approach to a portfolio of insurance claims provided by Czech Insurers' Bureau. This method supplements reserve estimation using state-space modeling of aggregated claims stacked to the form of a time series. In addition to that, we also use a method of clustering in order to split the data into several homogeneous groups. This should result in the computation of more reliable reserves.

[4209] *Machine Learning Approach to analyze the relation of Financial Performance and Sports Performance in Football Clubs*

Gianmarco Candura (Università Politecnica delle Marche, Ancona), Emilia Fares (LUISS Guido Carli, Roma), Giovanni Masala (Dipartimento di Scienze Economiche e Aziendali, Università di Cagliari, Cagliari) and Filippo Petroni (Università Politecnica delle Marche, Ancona).

For many years it was thought that finance, understood as a process of investing in entrepreneurial activities, applied to the world of sport, generated "monsters". This incompatibility of the football business with the financial world was based on numerous variables beyond the investor's control (for example injuries, refereeing errors against, a hostile sports "square" or obsessive media attention towards some players). These circumstances represent fundamental elements that can heavily affect the mood of investors (as explained in multiple theories of behavioral finance). In particular, the performance of a team can have a strong impact on the optimism or pessimism of an individual investor, then, it is difficult to measure the risk of an investment of this type [1, 2]. However, the situation in recent decades seems to have changed radically, aligning more and more football stocks with the major trends in the economy and in society. Therefore, if on the one hand, the number of football clubs listed on the stock markets has grown exponentially, on the other hand, a greater interest must also be recognized on the part of subjects belonging to other economic areas who choose for reasons of status, for the desire for visibility on an international scale (see Russian oligarchs, Arab Emirates or Chinese and Southeast Asian multi-billionaires) or as an object of economic exploitation (purely US-style growth-oriented mentality) to acquire ownership of European football clubs directly or by means of funds to control them. The paper aims to provide a general overview of the European football sector trying to grasp the dynamics existing in the 'industry'. Firstly, an analysis of the time series of the stocks of European football at high levels is carried out, trying to grasp the peculiarities and differences that can be found be- tween the most important clubs in the European competitive landscape. By means of portfolio optimization techniques, different stock market indices based only on football club stocks are used to assess the "maturity" of the football stock sector. Then, machine learning is used to verify the dependence of stock performance on the team's performance showing a relation between them. The application of ML techniques in this sector constitutes an innovative aspect with respect to the examined literature.

[4210] *Forecasting Tangency Portfolios and Investing in the Minimum Euclidean Distance Portfolio to Maximize Out-of-Sample Sharpe Ratios*

Nolan Alexander (University of Virginia) and William Scherer (University of Virginia).

We propose a novel model to achieve superior out-of-sample Sharpe ratios. While most research in asset allocation focuses on estimating the return vector and covariance matrix, the first component of our novel model instead forecasts the future tangency portfolio, and the second component then determines the optimal investment portfolio. First, to forecast the tangency portfolio, we forecast the efficient frontier by decomposing its functional form, a square root second-order polynomial, into three interpretable coefficients, which can then be used to calculate a forecasted tangency portfolio. These coefficients can be forecasted using vector autoregressions. Second, the model invests in the portfolio on the efficient frontier that is the minimum Euclidean distance from this forecasted tangency portfolio. A motivation for our approach is to address the limitation that the tangency portfolio only maximizes the Sharpe ratio when future returns and covariances are stationary, and can be directly estimated with historical data, which often does not hold in out-of-

sample data. Our approach addresses this shortcoming in a novel way by forecasting the tangency portfolio, rather than estimating return and covariance. For empirical testing, we employ two sets of assets that span the market to demonstrate and validate the performance of this novel method.

[4272] *Dust forecast during FIFA world cup Qatar 2022*

Rajmal Jat (Indian Institute of Tropical Meteorology, Pune, Maharashtra, India), Prafull P. Yadav (Indian Institute of Tropical Meteorology, Pune, Maharashtra, India), Gaurav Govardhan (Indian Institute of Tropical Meteorology, Pune, Maharashtra, India), Krishna Kumar Kanikicharla (Qatar Meteorology Department, Civil Aviation Authority, Doha, Qatar) and Sachin D. Ghude (Indian Institute of Tropical Meteorology, Pune, Maharashtra, India).

Dust storms are a recurrent phenomenon in Middle Eastern countries, posing significant threats to human health and infrastructure. Therefore, timely prediction and forecasting of such events is crucial to mitigate their impact. The Indian Institute of Tropical Meteorology (IITM), Pune, in collaboration with the Civil Aviation Authority Qatar Meteorology Department, Doha, has developed a Dust Early Warning System for Qatar to address this concern. The system's efficacy was tested during the FIFA World Cup Qatar 2022. The Dust Early Warning System utilizes the Weather Research and Forecasting Model coupled with Chemistry (WRF-Chem) as its core and generates a 96-hour forecast each day. Meteorological Initial and boundary conditions (IC/BC) are acquired from the IITM-Global Forecasting System (IITM-GFS, T1534) spectral model's analysis and forecast product (Ensemble-Kalman filtering) at a 12.5 km grid spacing, available every three hours. The MOZART-4 gas-phase chemistry with GOCART aerosol scheme is employed to represent the gas-phase chemistry and aerosol processes in the atmosphere. Anthropogenic emissions are acquired from the EDGAR-HTAP global emission database, while online dust emission is simulated using the Air Force Weather Agency (AFWA) dust scheme. Forecast verification of dust concentrations and meteorological parameters during the FIFA World Cup was performed using ground-based observations from Doha International Airport, Qatar. The detailed results of this verification will be presented at an upcoming conference.

[4313] *Review and potentials of tourist management in the fourth industrial revolution*

Enrique García-García (UNED), Diqian Ren (University of Dayton), Sergio Gallego-García (UNED) and Manuel García-García (UNED).

Tourism represents a key role in many economies. Disruptions such as pandemics represent a major risks for existing business models as well as for the attraction of new investments due to the high level of uncertainty. For this reason this paper seeks to provide a review of the current state of the art as well as an approach towards use cases for enhancing the collaboration and adaptability mechanisms of tourism enterprises in order to ensure their sustainability over time

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[4324] *Meteorology Effects over the Spanish Insular Electricity Consumption*

Eduardo Caro Huertas (Universidad Politécnica de Madrid) and Jesús Juan Ruiz (Universidad Politecnica de Madrid).

The short-term consumption forecasting software of the transmission system operator of any electric power network relies heavily on the effects of meteorological conditions. In this study, the impact of temperature and radiation on the hourly electric energy load in Spain's insular systems is thoroughly examined.

The effects of maximum and minimum daily temperatures, thermic lag effects, the interaction between temperature and non-working days, and the influence of temperature on the electricity demand for ten Spanish island systems are examined in detail. The mathematical model used in this study is currently in use by the Spanish Transmission System Operator (Red Eléctrica de España, REE) to forecast electricity demand hourly for a period of one to ten days in the future.

[4411] *Formation of a Forecast of Time Series of Data for the Purposes of Anomaly Detection Using a Digital Signal Processing Unit Connected in Series and an Artificial Neural Network - a Predictive Autoencoder*

Anastasiya Pletenkova (The South Ural State University) and Andrey Ragozin (The South Ural State University).

In order to improve the quality of forecasting time series of data observed from sensors in automated process control systems (APCS), it is proposed to use a predictive module consisting of a serially connected digital signal processing unit (DSP) and a predictive unit using a neural network (predic-tive autoencoder (PAE)). For the purpose of detecting anomalies in the op-eration of the APCS, high requirements are imposed on the quality of the generated forecast for the generated forecast, the observed time series of the APCS. When anomalies occur in the operation of the APCS, structural changes will occur in the error signal of the generated forecast, and as a re-sult of the analysis of these structural changes in the forecast error, in fact, anomalies are detected in the observed processes of the APCS. The work shows that the predictive module proposed in the work, consisting of a se-ries-connected DSP block and a predictive block using the PAE neural net-work, allows predicting time series of data with higher accuracy, which im-proves the quality of anomaly detection in the observed processes of APCS.

[4420] *Quadratic Mixed Integer Programming for deleting outliers in time series models*

Vassiliki Karioti (Assistant Professor at the Department of Tourism Management).

We consider the problem of deleting outliers in time series models. The problem is formulated as a Quadratic Mixed Integer Programming (QMIP) problem, where penalty costs for discarding outliers are used into the objective function. This method improves the estimator efficiency by down-weighting outliers, either AO or/and IO outliers. The QMIP problem has high computational complexity, so the proposed robust procedure is applied to small sample data. The scope of the proposed formulation were based on the idea to restrict the down-weighting resource. Then, the estimator selectively down-weights "bad" leverage points by allocating optimally the pulling resource. As optimality criteria, the leverage measure h_i and the residual u_i were considered.

[4445] *PREDICTIVE ACCURACY OF LOGIT REGRESSION FOR DATA-SCARCE DEVELOPING MARKETS: A NIGERIA & SOUTH AFRICA STUDY.*

Jonathan Oladeji (University of Pretoria), Benita Zulch (University of Pretoria) and Joseph Yacim (University of Pretoria).

This research examines how much forecasting accuracy can be achieved by modelling the relationships between listed real estate and macroeconomic time series variables using the logit regression model. The example data for this analysis included a 10-year (2008 – 2018) transactions. The Statistical Package for Social Sciences (SPSS) and Microsoft Excel were used for descrip-tive and inferential analysis of the data collected on the listed real estate transactions for South Africa and Nigeria. The study found that 22.2% vari-ance in the Nigerian real estate market were explained by the lending rate, treasure bill rate, and Consumer Price Index, while 9.4% variance in the South African real estate market were explained by changes in the exchange rate and coincident indicators. The strength and similarity of the model capacity in both countries showed that each market signal have predictive accuracy of 75% (Nigeria) and 80% (South Africa). The study found that South Africa's macroeconomic indicators demonstrate stronger predictive accuracy than the Nigerian macroeconomic indicator series. Meanwhile, the time series of Nigerian macroeconomic data demonstrates stronger influence on listed real estate than in South Africa.

[4467] *Adaptive Mahalanobis kernel for gaussian kernel adaptive filters*

Juan David Hernández-Sánchez (Universidad Tecnológica de Pereira), David Augusto Cárdenas-Peña (Universidad Tecnológica de Pereira) and Álvaro Ángel Orozco-Gutiérrez (Universidad Tecnológica de Pereira).

Adaptive filters are a class of learning algorithms devoted to online signal processing. Their kernel version, Kernel Adaptive Filter (KAF), develops the traditional linear filters in a reproduced kernel Hilbert apace, making them nonlinear filters in the input space. Among the various feasible kernel functions, the universal approximation property of Gaussian kernels makes them the standard choice. However, the election of an optimal kernel bandwidth remains an open research line as there lacks a well-established automatic tuning procedure. Despite achieving acceptable performance results, the presence of nonlinear chaotic signals, fast dynamics to follow, and non-stationarities hamper the performance of fixed bandwidths. Then, adaptive approaches become more suitable. This work introduces an online update rule for learning a metric able to indirectly optimize the kernel bandwidth. The experiments contrast the proposed approach against the conventional QKLMS and a well-known adaptive bandwidth algorithm in predicting time

series from nonlinear systems, chaotic attractors, and real data. Results evidence performance improvements in prediction accuracy, convergence rate, and compact modeling.

[4479] *Productivity loss related to premature cancer mortality in Brazil in three decades (2001-2030)*

Marianna De Camargo Cancela (Brazilian National Cancer Institute), Jonas Eduardo Monteiro dos Santos (Brazilian National Cancer Institute), Leonardo Borges Lopes de Souza (Brazilian National Cancer Institute), Luís Felipe Leite Martins (Brazilian National Cancer Institute), Dyego Souza (Federal University of Natal), Anton Barchuk (Tampere University), Paul Hanly (National College of Ireland), Linda Sharp (Newcastle University), Alison Pearce (The University of Sidney) and Isabelle Soerjomataram (International Agency for Research on Cancer).

BACKGROUND: Studies assessing productivity loss related to premature cancer mortality in Brazil are limited. This study aimed to calculate the Years of Potential Productivity Life Lost (YPPLL) and productivity loss due to premature cancer mortality in Brazil between 2001-2015 and project this up to 2030.

METHOD: We defined premature mortality as those occurring before retirement age: 65 and 60 years for men and women, respectively. Mortality data from all types of cancer were obtained from the Ministry of Health. Economic data and population were obtained from the Brazilian Institute of Geography and Statistics databases. The Human Capital Approach method was applied to estimate productivity loss.

RESULTS: Between 2001-2015, there were 591,641 deaths among men and 437,917 among women. Between 2016-2030, we estimate 737,207 deaths among men and 557,669 among women. Among men, the highest ASR cancer mortality was observed for lung and trachea (12.8 in 2001-2005 to 7.2 in 2026-2030), stomach (9.4 in 2001-2005 to 5.9 in 2026- 2030) and lips, oral cavity and pharynx (7.3 in 2001-2005 to 5.4 in 2026-2030). Among women, the highest ASR cancer mortality was observed for breast (11.1 in 2001-2005 to 11.8 in 2026-2030), cervical (8.0 in 2001-2005 to 6.9 in 2026-2030) and lungs and trachea (4.1 from 2001-2005 to 3.8 in 2026-2030). There were 32.2 million YPPLL, corresponding to USD 141 billion: 15.5 million YPPLL (USD 102 billion) among men and 16.6 million YPPLL (USD 38.8 billion) among women.

CONCLUSION: The substantial economic and social impacts of premature mortality from cancer in Brazil highlight the need to strengthen public policies to promote a population-based healthy lifestyle and reduce cancer morbidity and mortality.

[4496] *Exploring Uncertainty Intervals and Characteristics in Time Series Prediction: Incorporating Data Uncertainty and Interpretability*

Direnc Pekaslan (University of Nottingham), Christian Wagner (University of Nottingham) and Jonathan M. Garibaldi (University of Nottingham).

The interpretability and interactivity components are fundamental in time series prediction as they aid stakeholders in comprehending the rationale behind the generated predictions and facilitate their ability to engage with the system. In this paper, an extension framework of the Mamdani fuzzy logic system is introduced for generating uncertainty intervals in time series prediction while preserving the essential features of interpretability and interactivity in the system. Accurate forecasting is a challenging task due to the high levels of uncertainty present in real-world environments. Therefore, providing uncertainty intervals is essential to understand the forecast and reducing the risks of having erroneous predictions. While recent developments in prediction interval techniques have mainly concentrated on defining a single type of interval characteristic -such as symmetry- it is also essential not to overlook the interpretability aspect of such systems. The proposed approach extends the potential of the Mamdani fuzzy logic system by utilising the uncertainty affecting the systems, captured in fuzzy sets (FSs), to provide various interval characteristics, such as non-symmetricity, heterogeneity, and heteroskedasticity during multi-step ahead predictions, while maintaining the interpretability of the system. Moreover, the proposed approach incorporates data uncertainty during the prediction process, ensuring the generated uncertainty intervals are more representative of the actual uncertainties present in the data. In the experiment, the Mackey Glass chaotic time series is used as a case study to evaluate the proposed approach for generating uncertainty intervals in time series prediction. The primary objective of this experiment is to investigate the potential of the interpretable Mamdani fuzzy logic system for generating uncertainty intervals that exhibit various

characteristics while maintaining the interpretability of the system. We evaluate the proposed approach by providing prediction coverage and discussing the characteristics of the generated intervals. We analyse how the model extracts these characteristics and how they may impact the interpretation of the forecast. Through the analysis of the generated intervals, we highlight the ability of the proposed approach to provide a more comprehensive exploration of the range of possible interval characteristics, including non-symmetricity, heterogeneity, and heteroskedasticity. Furthermore, we demonstrate the integration of data uncertainty into the proposed approach, enhancing the generated intervals' representativeness of the actual uncertainties present in the data. Lastly, we examine the potential implications of these characteristics for decision-making processes in various fields. The discussion of the generated intervals and their characteristics provides insights into the potential implications of our proposed approach for decision-making processes in various fields. In conclusion, the proposed approach offers a contribution to the field of time series prediction by providing a more comprehensive exploration of un- certainty intervals in interpretable systems. The experiment with the Mackey Glass chaotic time series serves as a demonstration of the approach's potential and highlights its ability to provide uncertainty estimates with various characteristics that reflect the actual uncertainties present in the data. Overall, the proposed approach can improve decision-making processes in various fields by providing more representative and interpretable uncertainty estimates.

[4502] *Stock Embeddings: Representation Learning for Financial Time Series*

Rian Dolphin (University College Dublin), Barry Smyth (University College Dublin) and Ruihai Dong (University College Dublin).

Identifying meaningful and actionable relationships between the price movements of financial assets is a challenging but important problem for many financial tasks, from portfolio optimization to sector classification. However, recent machine learning research often focuses on price forecasting, neglecting the understanding and modelling of asset relationships. To address this, we propose a neural model for training stock embeddings that harnesses the dynamics of historical returns data to reveal the nuanced correlations between financial assets. We describe our approach in detail and discuss several practical ways it can be used in the financial domain. Specifically, we present evaluation results to demonstrate the utility of this approach, compared to several benchmarks, in both portfolio optimization and industry classification.

[4525] *Inventory improvement in tyre retail through demand forecasting*

Magda Monteiro (ESTGA, University of Aveiro), Diana Neves (ESTGA, University of Aveiro) and Maria José Felício (ESTGA, University of Aveiro).

The aim of this study is to develop the inventory planning system of a Portuguese tyre retailer, based on forecasting sales models. Using sales history up to 2020, tyres were grouped into three levels of sales aggregation and different quantitative forecasting models were applied. The comparison of these models resorted to various evaluation measures to choose the most suitable for each group. The study shows that, for items whose sales were grouped monthly, Holt's method had a better performance on determining sales forecasts, while for tyres with sales grouped quarterly, it was Croston's method that stood out. Regarding the items with sales grouped by semester, Holt's method had the best performance. The inventory policy outlined for each group of items reflects the results of the forecasted demand and the review period depends on the sales group under analysis. In agreement with previous studies, the usefulness of statistical methods is corroborated. Additionally, the advantage of combining said methods proved helpful, particularly as a starting point for tyre retail inventory planning.

[4538] *A note on testing for threshold non-linearity in presence of heteroskedasticity in time series*

Greta Goracci (Free University of Bolzano-Bozen, Faculty of Economics and Management) and Simone Giannerini (University of Bologna).

We study the behaviour of an asymptotic test for linearity against the threshold autoregressive moving average model in presence of conditional heteroskedasticity. We recall the relevant asymptotic theory both under the null and the alternative hypotheses for a supremum Lagrange Multiplier test statistic in presence of i.i.d errors. By means of a small simulation study we show that when the innovations follow a GARCH process the size of the test can be severely biased and we discuss possible solutions to the problem.

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[4550] *Online Pentanes Concentration Prediction System based on Machine Learning Techniques*

Diana Manjarres (TECNALIA, Basque Research and Technology Alliance (BRTA)), Erik Maqueda (TECNALIA, Basque Research and Technology Alliance (BRTA)) and Itziar Landa (Petronor Innovación).

Industry 4.0 has emerged together with relevant technological tools that enable to give rise to this new industrial paradigm. One of the main employed tools is the Machine Learning techniques that allow to extract knowledge from raw data and therefore, devise intelligent strategies or systems to improve actual industrial processes. In this regard, this paper focuses on the development of a prediction system based on Random Forest (RF) to estimate in advance the Pentanes concentration. The proposed system is validated offline with more than a year of data and also is tested online in an Energy plant of the Basque Country. Validation results show acceptable outcomes for supporting the operators decision-making with a tool that infers the Pentanes concentration in Butane 400 minutes in advance and therefore, the quality of the obtained product.

[4664] *Probabilistic forecast reconciliation: cross-temporal framework*

Daniele Girolimetto (Department of Statistical Sciences, University of Padua), George Athanasopoulos (Department of Econometrics and Business Statistics, Monash University), Tommaso Di Fonzo (Department of Statistical Sciences, University of Padua) and Rob J Hyndman (Department of Econometrics and Business Statistics, Monash University).

Forecast reconciliation is a post-forecasting process that maps a set of incoherent forecasts into coherent forecasts which satisfy a given set of linear constraints for a multivariate time series. Classical reconciliation (bottom-up, top-down and middle out) methods address the issue of incoherent forecasts in a hierarchical structure by forecasting only one level and then propagating these forecasts along the other levels of the structure. These approaches ignore useful information available at other levels. Consequently, in the last decade, hierarchical forecasting and forecast reconciliation have significantly evolved to include modern least squares-based reconciliation techniques in the cross-sectional framework, later extended to temporal and cross-temporal framework. Recently, Di Fonzo & Girolimetto (2023) suggested a unified reconciliation step that considers both the cross-sectional and temporal dimensions, instead of dealing with them separately, utilizing the entire cross-temporal hierarchy. However, they focus on point forecasting, and do not consider distributional or probabilistic forecasts (Gneiting & Katzfuss 2014). In the cross-sectional framework, Panagiotelis et al. (2023) made a significant contribution by formalizing cross-sectional probabilistic reconciliation using the geometric framework for point forecast reconciliation and giving useful insights on the computation of the forecasts. In this work we extend the state-of-the-art cross-sectional probabilistic forecast reconciliation to the cross-temporal framework, where temporal constraints are also considered. We expand and unify the notation for cross-sectional, temporal and cross-temporal reconciliation and investigate the probabilistic cross-temporal framework in more detail. A non parametric bootstrap and a parametric Gaussian approach to draw samples from an incoherent cross-temporal distribution are developed. The multi-step residuals are used for a better estimation of the covariance matrix, specifically in the time dimension where the in-sample residuals fail. To address the high-dimensionality issues, we propose four alternatives for the covariance matrix by exploiting the two-fold nature (cross-sectional and temporal) of the cross-temporal structure and consider overlapping residuals. A simulation study is performed to investigate the theoretical and empirical proprieties of the different approaches. The methodological contributions are implemented in the FoReco package for R (Girolimetto & Di Fonzo 2023). Finally, we consider two empirical forecasting experiments using the Australian GDP and the Australian Tourism Demand datasets to evaluate the feasibility and the performance of the proposed procedures. For these applications, the optimal cross-temporal reconciliation approaches significantly outperform the base forecasts according to the Continuous Ranked Probability Score and to the Energy Score. The results show the effectiveness of the proposed techniques in improving the accuracy of probabilistic forecasts.

References

Di Fonzo, T. & Girolimetto, D. (2023), 'Cross-temporal forecast reconciliation: Optimal combination method and heuristic alternatives', International Journal of Forecasting 39(1), 39–57.

Gneiting, T. & Katzfuss, M. (2014), 'Probabilistic Forecasting', Annual Review of Statistics and Its Application 1(1), 125–151.

Girolimetto, D. & Di Fonzo, T. (2023), FoReco: Point Forecast Reconciliation. R package v0.2.6. URL: https://danigiro.github.io/FoReco/

Panagiotelis, A., Gamakumara, P., Athanasopoulos, G. & Hyndman, R. J. (2023), 'Probabilistic forecast reconciliation: Properties, evaluation and score optimisation', European Journal of Operational Research 306(2), 693–706.

[4715] *Assessing the water quality effluent from a treatment plant*

Alina Barbulescu (Transilvania University of Brasov), Lucica Barbes (Ovidius University of Constanta and Politehnica University of Bucharest) and Cristian Stefan Dumitriu (Technical University of Civil Engineering, Bucharest, Romania).

Water is an essential element for sustainable environmental development, a good water quality being a must for human life. Drinking water quality is of main importance for the population's health. Therefore, the article aims to study the water quality before entering and after its exit from a treatment plant situated in the southeastern part of Romania. Firstly, statistical analysis of each series water parameter is performed. Then, the water quality is assessed using water quality indices. The efficiency of the treatment plant is evaluated by introducing some quality indicators. Finally, artificial intelligence models for the series of water parameters evolution (in time) are proposed to evaluate the water quality in certain conditions.

[4773] *Gaining flexibility by rethinking offshore outsourcing for managing complexity and disruption*

Michela Pellicelli (University of Pavia).

The challenges confronting management in making decisions on offshore outsourcing have inevitably changed dramatically over the last decade. Offshore outsourcing today is characterized by a higher level of complexity and disruption brought about mainly factors of change, as: 1) the new waves of globalization; 2) the rapidly shifting conditions in the marketplace, which have made offshoring a vital part of global strategies, leading the way to new business models; 3) the increasing variety of models in the global supply chain; 4) the inroads of previous providers that have emerged as world-class competitors; and 5) the irresistible march of technological disruption. Threatening events, as terrorist attacks and wars, had disrupted the world economy since the 2000s. In these cases, supply chains were disrupted although soon restored. After these critical events, globalization was severely weakened by the arrival of the COVID-19 pandemic, on the threshold of 2020, and Russia's invasion of Ukraine dealt a blow to global supply chains, by 2022. Due to these complexities, the trend to outsource production to other countries might increasingly push companies to transform themselves into virtual organizations, where all functions can be outsourced through the formation of flexible networks and agile organizational structures.

[4779] *GEODYNAMIC MODELING IN CENTRAL AMERICA BASED ON GNSS TIME SERIES ANALYSIS. SPECIAL CASE: THE NICOYA EARTHQUAKE (COSTA RICA, 2012)*

Paola Barba Ceballos (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Nely Pérez-Méndez (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Javier Ramirez (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Belén Rosado (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Vanessa Jiménez Morales (Departamento de física teórica y del cosmos. Universidad de Granada) and Manuel Berrocoso (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz).

GNSS systems allow precise resolution of the geodetic positioning problem through advanced techniques of GNSS observation processing (PPP or relative positioning). Current instrumentation and communications capabilities allow obtaining geocentric and topocentric geodetic high frequencies time series, whose analysis provides knowledge of the tectonic or volcanic geodynamic activity of a region. In this work, the GNSS time series study is carried out through the use and adaptation of R packets to determine their behaviour, obtaining displacement velocities, noise levels, precursors in the time series, anomalous episodes and their temporal forecast. Statistical and analytical methods will be studied; for example, ARMA, ARIMA models, least-squares methods, wavelet functions, kalman techniques and CATS analysis. To obtain a geodynamic model of the Central American region, the horizontal and vertical velocities obtained by applying the above methods will be taken, choosing the velocity with the least margin of error. Significant GNSS time series obtained in geodynamically active regions (tectonic and/or volcanic).

[4812] *A Measure of Bivariate Long Memories in Stock Returns*

Charles Mutigwe (Western New England University).

In this study we develop a prediction vector (PV) model where Granger causality is applied to pairs of stock prices over an expanding causal interval and a softmax function is used to aggregate the causal interval results. We test the PV model on eight U.S. financial markets instruments that consist of six common stocks that are related by industry, one commodity future and a mortgage interest rate. We use daily closing prices of the market instruments over a 15-year period. We find evidence of long memories among pairs of these instruments which suggests the existence of long-term market pricing inefficiencies.

[4830] *Simulation of the Queue Situation of Patients in the Health Center*

Kalle Saastamoinen (National Defence University of Finland/Military Technology), Antti Rissanen (National Defence University of Finland/Military Technology), Juho Suni (National Defence University of Finland/Military Technology), Juho Hyttinen (National Defence University of Finland/Military Technology), Petteri Paakkunainen (National Defence University of Finland/Military Technology) and Aaro Liakka (National Defence University of Finland/Military Technology).

In the starting point of the study, the garrison hospital performs an assess-ment of the need for treatment when the number of conscripts queuing for reception is at its highest level. The research aims to find out the reasons for conscripts' perceived long waiting times, which cause absences from con-scripts' training. According to the predictions made by queuing simulation, the hospital's staff is able to receive patients arriving for the morning reception without the queue time causing undue harm to training. However, in large congestion peaks, the waiting times may become unreasonable, which would require an increase in human resources. Peaks of congestion usually occur at the begin-ning of the week, as well as on days with heavy training.

[4932] *Novel estimators of the Ornstein-Uhlenbeck process using high-frequency data*

Petra Tomanová (Prague University of Economics and Business), Vladimír Holý (Prague University of Economics and Business) and Michal Černý (Prague University of Economics and Business).

Observing stock prices at high frequencies provides an opportunity to extract more information for estimating the parameters of the price process. However, such high-frequency data are contaminated by market microstructure noise, which can significantly bias parameter estimation if not accounted for. To address this challenge, we propose noise-robust estimators of the Ornstein-Uhlenbeck process that utilize high-frequency data.

To obtain initial estimates, we recommend using the closed-form method of moments. For regularly spaced observations, we propose an approach that involves reparametrizing the process into an ARMA(1,1) model, followed by estimation through either the maximum likelihood or conditional sum-of-squares methods. For irregularly spaced observations, we derive a logarithmic likelihood function. In the simulation study, we demonstrate that our proposed noise-robust estimators outperform traditional estimators that ignore the noise.

Moreover, in our empirical study of 7 Big Oil companies, we show that using our proposed Ornstein-Uhlenbeck process estimator results in a significant increase in the profitability of the pairs trading strategy. By taking into account the noise in the high-frequency data, our estimators provide traders with a more reliable basis for making informed investment decisions.

[4977] *Macroeconomic Adverse Selection in Machine Learning Models of Credit Risk*

Joseph Breeden (Deep Future Analytics LLC) and Yevgeniya Leonova (Deep Future Analytics LLC).

Macroeconomic adverse selection is computed as a time series of forecast residuals by vintage origination model for an industry dataset of auto loans. The adverse selection time series are computed separately as model residuals using logistic regression, neural networks, and stochastic gradient boosted trees to predict defaults in the first 24 months of a loan, then adverse selection was computed using the same techniques applied to panel data on loan performance with lifecycle and environment inputs from an Age-Period-Cohort model. The estimates show that panel data methods make better use available data to provide faster estimates of adverse selection risk in recent vintages. Further, the nonlinear

methods of NN and SGBT were not able to process all of the available data due to computational limitations, which may have led to some of the variation in adverse selection estimates in addition to the comparison of linear to nonlinear techniques. Overall, the best methods confirmed that macroeconomic adverse selection has been dramatically higher in 2021 and 2022 for US auto loan originations.

[5029] *Trends and cycles during the COVID-19 pandemic period*

Jose R Maria (Banco de Portugal) and Paulo Júlio (Banco de Portugal).

We devise a simple yet versatile strategy to perform trend-cycle decompositions in severe crisis periods, such as the COVID-19 pandemic period. The proposed strategy propels a great deal of volatility during this period into pandemic-specific shocks, with minimal impacts on non-pandemic disturbances. We start by estimating two unobserved components models until 2019:4, for Portugal and the euro area. We then introduce several pandemic-specific disturbances and estimate their variances during the 2020-21 period, keeping fixed all remaining model parameters. Finally, we bring together the information from both estimation stages through a piecewise linear Kalman filter, assuming such heteroskedastic environment. Our strategy has the attractiveness of generating negligible historical revisions when the 2020-2021 period is added to the estimation sample, despite the large pandemic disruption. Results suggest that innovations affecting the cycle are key drivers of GDP during the pandemic period, while yielding negligible historical revisions.

[5035] *Econometric modeling of the impact of the COVID19 pandemic on the volatility of the financial markets*

Abdessamad Ouchen (National School of Business and Management (ENCG) Fez, Sidi Mohamed Ben Abdellah University Fez (Morocco)).

The purpose of this paper is to identify econometric models likely to highlight the impact of the COVID19 pandemic on the financial markets. The Markov-switching "GARCH and EGARCH" models are suitable for analyzing and forecasting the series of daily returns of the major global stock indices (i.e. SSE, S&P500, FTSE100, DAX, CAC40 and NIKKEI225) during the pre-COVID19 period, from June 01 to November 30, 2019, and the post-COVID19 period, from December 31, 2019 to June 01, 2020. The Markov-switching "GARCH and EGARCH" models allow a good modeling of the conditional variance. The estimated conditional variance values by these models highlight the increase in volatility for the stock markets in our sample, during the post-COVID19 period compared to that pre-COVID19, with a peak in volatility in "early January 2020" for the Chinese stock market and in "March 2020" for the other five stock markets (i.e. New York, Paris, Frankfurt, London and Tokyo). The stock exchange of Frankfurt has shown a great resilience, compared to other international stock exchanges (i.e. the stock exchanges in Paris, London and New York). The modeling of the impact of the COVID19 pandemic on the financial markets by the Markov-switching "GARCH and EGARCH" models makes it possible to simultaneously take into consideration the nonlinearity at the level of the mean and the variance, and to obtain the results of the transition probabilities, the unconditional probabilities and the conditional anticipated durations during the pre-COVID19 period and the post-COVID19 period.

[5105] *MARINE BIOTA AND MICROPLASTICS INGESTION: A STATISTICAL APPROACH*

Andreea Mădălina Ciucă (Politehnica University of Bucharest, Doctoral School of Biotechnical Systems Engineering), Elena Stoica (National Institute for Marine Research and Development "Grigore Antipa") and Lucica Barbes (Politehnica University of Bucharest, Doctoral School of Biotechnical Systems Engineering).

Microplastics pollution is a significant environmental issue that negatively impacts marine ecosystems and wildlife and represents a topic that shows increasing interest from researchers worldwide. The ingestion of plastics by marine biota can cause physical harm and a range of health problems. To understand the extent and the impact of microplastics ingestion, we have conducted a review study on marine biota (cetaceans, birds, fish, and invertebrates) to show the current level of knowledge in the field, the type, color, and occurrence of ingested microplastics and also the main methods used to obtain results. The data collected from studies published between 2012 and 2022 has been subject to statistical analysis to identify patterns and trends in plastic ingestion and identify specific types of plastics that are more likely to be ingested by animals.

[5135] *Musical aptitude screening: a Brazilian experience un-der construction*

Fabiana Oliveira Koga (Universidade Federal de São Carlos), Rosemeire de Araújo Rangni (Universidade Federal de São Carlos) and Rafael Pereira (Instituto Federal da Bahia - Vitória da Conquista).

In Brazil, Law n. 9394/96 ensures rights such as the identification of talented stu-dents, in order to offer specialized educational attention, in this sense, the Proto-col for Screening of Musical Abilities was elaborated, with 54 items, and its complementary instruments (scales and questionnaires) in order to collaborate with the survey of students with indicators of musical talent. This work, there-fore, aims to present the instruments and the evidence of effectiveness and usability found, preliminarily. It is an investigation in progress in the experimental psychometric molds (elaboration of scales) and psycho-physical (peer comparison method). 800 individuals, children from six to 11 years old, their guardians (family members) and teachers take part in the research. The results have indicat-ed that participants with higher scores remain with the same indices in the later stage of evaluation, however, only from the statistical tests intended for valida-tion, standardization and reliability, as well as exploratory factor analysis will it be possible to attest the validity, standardization of scores and preparing the final version for wide use of the instruments

[5166] *Non-Invasive Arterial Blood Pressure Estimation from ECG and PPG Signals using a Conv1D - BiLSTM Neural Network*

Federico Delrio (Politecnico di Torino), Vincenzo Randazzo (Politecnico di Torino), Giansalvo Cirrincione (Univeristé de Picardie) and Eros Pasero (Politecnico di Torino).

This paper presents a neural network model to estimate arterial blood pressure (ABP) waveform using electrocardiogram (ECG) and photoplethysmography (PPG) signals and its first two order mathematical derivatives (PPG', PPG''). In order to achieve this objective, a lightweight and optimized neural network architecture has been proposed, made of Conv1D and BiLSTM layers. To train the network, the UCI Database ``Cuff-Less Blood Pressure Estimation Data Set" has been used, which contains ECG and PPG signals together with the corresponding ABP waveform data; then PPG first two derivatives have been computed. Four different configurations and parameter sets have been tested to choose the best structure and set of parameters. Also, various batch sizes, numbers of BiLSTM layers, and the presence of a maximum pooling layer have been tested. The best performing model achieves a mean absolute error of around 2.97, which is comparable to the state-of-the-art methods. Results prove deep learning techniques can be effectively used for non-invasive cuffless arterial blood pressure estimation. The lightweight and optimized model can be effectively used for continuous monitoring of blood pressure, which has significant clinical implications. Further research can focus on integrating the proposed model with wearable devices for real-time blood pressure monitoring in daily life.

[5185] *Generalization in the resolution of the VAR model in the dynamics of systems of simultaneous equations in differences*

Gerardo Covarrubias (National Autonomous of Mexico University) and Xuedong Liu (National Autonomous of Mexico University).

This paper presents a generalization of the solution for cointegration models of autoregressive vectors (VAR) in the long term from the approach of discrete-time dynamic solution of systems of simultaneous equations in differences that represent stochastic processes. The study is carried out by comparing the results obtained in the empirical estimation of two models with two variables, with one and two lags respectively in the E-views econometric software. Likewise, both models were solved as systems of difference equations, where consistency was obtained in the results and the cointegration equations. In this way, it was concluded that, once an adequate specification of the autoregressive models between variables is obtained to observe the cointegrating behavior in the long term, it is possible to generalize the methodology for i variables with j lags.

[5193] *Integrating weather and satellite data to model the effect of drought extremes on wheat response using time series analysis*

Tom Vanwalleghem (University of Cordoba) and Vanesa Garcia (University of Cordoba).

Accurate prediction of wheat yield is essential for agricultural management, food security warning and food trade policy. Drought is one of the major extreme weather events affecting crop yields. Although different statistical and process-based have been used to predict crop yields, relatively few studies have applied time series analysis. This paper uses Dynamic Factor Analysis to evaluate the effect of different hydroclimate variables; minimum and mean temperature, rainfall, evapotranspiration, soil moisture and standardized precipitation index (SPI-3). To evaluate plant response, we extracted time series of MODIS-derived normalized difference vegetation index (NDVI) at field scale, in 16 field plots across Southern Spain for the period 2003-2022. Analysis was done in R software, using the package "MARSS". We developed a DFA model exploring different models with 2 to 3 common factors. Adding additional variables such as SPI-3 or soil moisture did not improve the model significantly (AIC of 1168 compared to 1182). There is a strong variation in the common trends, and some indication of differences between the analyzed fields. The final model satisfactorily reproduced the observed NDVI variation. This demonstrates that DFA analysis shows a high potential for modelling the behaviour of cereal response and yields over time, as an alternative to traditional agronomic process-based modelling based on rainfall/temperature inputs only. Further research will be needed, evaluating the effect of additional covariates and extending the analyzed NDVI time series by incorporating more satellite images.

[5311] *Can LSTM outperform volatility-econometric models?*

German Rodikov (Scuola Normale Superiore di Pisa) and Nino Antulov-Fantulin (ETH Zürich, Switzerland | Aisot Technologies AG, Zürich, Switzerland).

Volatility prediction for financial assets is crucial for understanding financial risks. Despite recent deep learning advancements, they often struggle to outperform robust econometric volatility models due to the complexity arising from noise, market microstructure, heteroscedasticity, news effects, and various time scales, among other factors. This study examined the Long Short-Term Memory (LSTM) recurrent neural networks for volatility prediction and compared them with prominent volatility-econometric models. Our investigation focused on the influence of the input dimensionality hyperparameter and LSTM architecture on performance. The results suggest that optimal input dimensionality ranges from 7 to 12 values, and deeper LSTM models may not guarantee improved performance. We also investigated the effects of both preprocessing and hyperparameter optimization in improving the overall results. Our study underscores the importance of carefully considering the input dimensionality hyperparameter, LSTM architecture, and hyperparameter tuning in volatility prediction tasks.

[5326] *Hierarchical Multiple Regression and Principal Component Analysis for Investigating the Driver Behavior in Kuwait toward Willingness to Give Way to Emergency Medical Service (EMS) Vehicles*

Sharaf Alkheder (Civil Engineering Department, College of Engineering and Petroleum, Kuwait University).

Emergency Medical Services is an important public issue that concerns both fields of health and transportation significantly. Therefore, studying the emergency response aspects in Kuwait is considered crucial. This investigation is achieved through studying the factors and Behaviors of drivers and their willingness to give way to the ambulance vehicles in Kuwait. The study was designed based on a survey dataset. For the data collection, Microsoft Forms website has been used. A survey was answered by 830 drivers based on the methodology of Wang and Xu (2021) and an extended theory of planned Behavior (TPB). TPB model focus on the factors which may have an impact on the decision to give way to the ambulance. The data were analyzed using hierarchical multiple regression and principal component analysis. The results have shown that out of all TPB factors, the attitude had a negative impact on the willingness, while the rest TPB factors had a positive impact. Furthermore, all of the demographic variables have a significant impact on the willingness to give way to ambulances except for the education level. Finally, people who use the shoulder lane are less likely to give way to the ambulance in comparison with those who do not use it.

[5381] *On Forecasting of Carbon Allowance Futures Prices and Parametrisation of two-factor model*

Jun Han (Macquarie University), Nino Kordzakhia (Macquarie University), Pavel Shevchenko (Macquarie University), Stefan Trueck (Macquarie University) and Karol Binkowski (Macquarie University).

In this study, we consider the extended two-factor model which was originally introduced by Schwartz and Smith (2000), and since then it has been commonly used for pricing of commodity derivatives. In the extended two-factor model, we assume that error terms in the measurement equation system are serially correlated and inter-dependent. We derive the Kalman filter using measurement equations with correlated AR(p) error processes. We will estimate the latent state variables and the model parameters utilising the Kalman filter and maximum likelihood estimation method, respectively. A comparative analysis is performed using various reduced-form models to assess the goodness-of-fit and out-of-sample forecast. The results of empirical study, including in- and out-of-sample forecasts, will be discussed. In this study we use the historical daily prices of European Union Allowance (EUA) futures contracts from January 30, 2017 to January 30, 2023.

[5498] *Financial Time Series Models - Comprehensive Review of Deep Learning Approaches and Practical Recommendations*

Mateusz Buczynski (Faculty of Economic Sciences University of Warsaw; Interdisciplinary Doctoral School University of Warsaw), Marcin Chlebus (Faculty of Economic Sciences University of Warsaw), Katarzyna Kopczewska (Faculty of Economic Sciences University of Warsaw) and Marcin Zajenkowski (Faculty of Psychology University of Warsaw).

There have been numerous advances in financial time series forecasting in recent years. Most of them use deep learning techniques. We have identified 15 outstanding papers that have been published in the last seven years and have tried to prove the superiority of their approach to forecasting one-dimensional financial time series using deep learning techniques. In order to objectively compare these approaches, we analysed the proposed statistical models and then reviewed and reproduced them. The models were trained to predict, one day in advance, the value of 25 indices, stock and commodity prices over 5 different time periods (from 2017 to 2022), with 4 in-sample years and 1 out-of-sample year. Our findings indicate that, first of all, most of these approaches do not beat the naive in-sample approach, and only some barely beat it. Most of the researchers did not provide enough data necessary to fully replicate the approach, not to mention the codes. We therefore re-optimised the models to find different sets of hyperparameters than those reported. Finally, we selected the top 5 models from this sample to provide a more realistic model testing scenario - daily model retraining. This proved that these top 5 models are able to outperform the naive approach, but there is no single model that is the best regardless of the test sample. We provide a set of practical recommendations of when to use which models based on the datasample that we provided.

[5513] *GPU-APUMPEDI: A Parallel Algorithm for Computing Approximate Pan Matrix Profiles of Time Series*

Jing Zhang (Mitsubishi Electric Research Laboratories (MERL)), Daniel Nikovski (Mitsubishi Electric Research Laboratories (MERL)) and Takaaki Nakamura (Mitsubishi Electric Corporation).

The Matrix Profile (MP) of a test time series with respect to a base time series has been shown to be a versatile primitive for many data mining tasks including time series anomaly detection. The MP records distances from all subsequences in the test time series to their respective nearest neighbors in the base time series. The Pan Matrix Profile (PMP) is a matrix with each row being an MP corresponding to a single subsequence length, and computing explicitly an exact PMP is slow. We propose a GPU-based approximation algorithm called GPU-APUMPEDI to compute the PMP under unnormalized Euclidean distance by combining GPU-based MP algorithms and linear interpolation. We validate its efficiency and effectiveness through extensive numerical experiments on the UCR Anomaly Archive.

[5526] *Aviation technology evolution and roadmap of Hong Kong*

Pengyu Zhu (Hong Kong University of Science and Technology), Ning Chen (Hong Kong University of Science and Technology), Swathi Akella (Hong Kong University of Science and Technology) and Jeffrey Chow (Hong Kong University of Science and Technology).

In order to transform itself into a sustainable aviation industry and enable the next growth phase, Hong Kong has successfully adopted various digital technologies. Having developed a strong position in the aviation industry, the Hong Kong International Airport (HKIA) has come to be a leader in the technological evolution of the aviation industry and has also inspired other stakeholders in the aviation industry to follow suit. Following its technological evolution, HKIA, as an important centre of the air transport industry in Asia and even the world, will undoubtedly play a demonstrating and

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leading role for relevant stakeholders in the world's aviation industry. At the same time, the COVID-19 pandemic urged HKIA and other global airports to accelerate the pace of innovation and technology applications and make more progress in the digitalisation and unmanned management of airports. This paper highlights the technologies adopted by HKIA and the resulting progress as well as proposes a technological evolution roadmap for the coming years. Based on our research, we have identified airport security, passenger service and airport management as three application areas for future technological innovation in HKIA. The technological roadmap divided over periods of short, medium and long terms proposes application of disruptive new-age technologies such as contactless body scanners for comprehensive yet seamless airport security, robotics and intelligent systems for enhancement of passenger experience and data analytics and artificial intelligence power solutions such as digital twin for efficient and sustainable airport management.

[5558] *A deep learning model for generalised surface water flooding across multiple return periods*

Syed Kabir (JBA Risk Management Limited), David Wood (JBA Risk Management Limited) and Simon Waller (JBA Risk Management Limited).

Flood modelling is essential for addressing a range of scientific and engineering challenges. In recent years, the high computational demands of solving Shallow Water Equations (SWE) numerically have led researchers to explore machine learning-based emulators for predicting floods and flood risk. Specifically, continuing Convolutional Neural Network (CNN) proliferation in solving different scientific problems has encouraged researchers to investigate its applicability in flood modelling. For example, Kabir et al., (2020) used a simple CNN-based model to estimate fluvial flood depths using upstream flows. Gou et al., (2021) used topographical features and rainfall as inputs in their U-Net like model for surface water flooding. Most recently, Gou et al., (2022) has shown that the U-Net can estimate maximum flood depths for a fixed rainfall event (100-year return period in their study) using only topographical features. We present here a new U-Net architecture which has the capacity to approximate maximum flood depths for multi-return period events using a different batch of inputs that we found to be more appropriate. In this study, 27 catchments from the United Kingdom are used to train, validate, and test the model performance. The catchments overlap at the boundaries with neighbouring catchments and out of 27 catchments, 25 are used for training and validation and 2 are left aside for testing purposes. The peak flood depths occurring in the hydrologic simulation for 20, 100, and 1000-year rainfall return periods, along with DEM and water body masks are utilised to train the U-Net. The maximum flood depth files are generated using the JFlow (inhouse 2D hydraulic model of the JBA group) software. The spatial resolution of the data is 5m. However, the files are remapped to 10m. This is to reduce further training time. The U-Net is a U-shaped encoder-decoder network consisting number of convolutional and deconvolutional layers. The model under consideration has seven convolutional layers in its encoder segment and seven deconvolutional layers in its decoder segment. It is worth noting that the size of the catchments is large and therefore, cannot be used directly as inputs due to memory issues. Therefore, the catchments are divided into smaller patches of 1024x1024 cells. Slope and flow accumulation information are also extracted from the DEM and used as separate input data, as well as a water body mask. In other words, the input size of the U-Net is (1024 x 1024 x 4) and output size of the model is (1024 x 1024 x 3) where the third dimension refers to the three channels representing 20, 100 and 100-year flood depths (Figure 1). The model is trained and validated for 2000 epochs (each epoch is essentially a systematic rolling window of 1024 x 1024 cells over all the training and validation catchments). Finally, the trained mode is then applied to the test catchments for evaluation. The predicted flood maps are compared against the JFlow outputs using multiple error metrics, namely Root Mean Squared Error (RMSE), the modified index of agreement (d1) (Guo et al., 2022), and the F1 score. Smaller sub-domains are selected from the two test catchments to avoid any overlapping with training datasets. The model produced maps with a good agreement with the JFlow hydraulically modelled maps on the test catchments, with the RMSE, d1 and F1 values being 0.05m, 0.59 (1 is the optimal score) and 0.57, respectively. An example of the U-Net predicted map is illustrated in Figure 2 alongside JFlow generated map. An analysis of the outputs revealed that the U-Net has slightly overestimated flood extent and at the same it has underestimated flood depths. This behaviour is observed throughout the test catchments. The computational time for a 125 km2 catchment area is about 25 seconds. In this experiment we developed and tested a U-Net for rapid flood prediction using topographical features. The results show that the model has the potential of predicting flood depths in unknown catchments for multi-year rainfall return periods. However, the study also finds that such model often underestimates water depth and overestimates extent. Currently, research is ongoing to further improve model performance and quantify uncertainty.

[5794] *Data Mining Application for Empowering Demoethical Model*

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This article presents the application of the data mining method in substantiating the "4D = D + 3D" model, which means the study of demography, democracy, and demoeconomics based on demoethics issues. Demoethics is the basis of this model because the fundamental values of any society are spirituality and morality. Demoethics is the conceptual basis of tools to influence the sustainable development of demography, democracy, and demoeconomics. This study is based on the application of the data mining method for correlation modeling of assessing the influence of factors on the process of sustainable development of society. The results of the study allow for determining the integral indicator of the level of the sustainable and harmonious development of society, obtained using the model.

[5798] *Gaussian kernel estimator and bootstrap confidence intervals for correlation between time series sampled on different time points*

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In this work we discuss some asymptotic properties of the Gaussian kernel (GK) estimator for the correlation between two time series sampled on different time points and their relevance for the construction and interpretation of bootstrap based confidence intervals.In particular, we show that the GK estimator is asymptotically biased and converges to a weighted average of the cross-correlation function in a neighbourhood of zero. As a result, any bootstrap procedure for the construction of confidence intervals that combines the GK estimator with a standard method based on percentiles of its bootstrapped distribution(such the bias-corrected and accelerated method) asymptotically will have zero coverage even after applying recalibration. This does not imply, however, that bootstrap confidence intervals are useless. In fact, we show through an extensive simulation study, that a suitable block-bootstrap procedure can provide a useful lower bound for the absolute correlation and, in some special cases, confidence intervals with approximately the correct coverage. The ideas explored in this work apply as well to the more general problem of estimating the cross-correlation function of a bivariate time series whose components are sampled on different time points using a kernel-based estimator.

[5852] *Performance of Negatively Screened Sustainable Investments during the COVID-19*

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The negative screening is an important strategy for building up an environmental, social, and governance (ESG) portfolio by excluding low ESG scored assets from a conventional portfolio. This paper aims at evaluating the performance of the ESG negative screened index in comparison to corresponding parent index under different market conditions. Based on the standard capital asset pricing model (CAPM), framework, two types of parent index are considered. When the parent index is a market benchmark, abnormal return can directly be used. Otherwise, risk-adjusted abnormal return needs to be considered. Markov Regime Switching Autoregressive model is employed to identify the different regimes in modelling market conditions. The study analyzes 24 negatively screened ESG indices from the S&P, DJSI and MSCI across various regions, sizes of underlying firms, and criteria of screening. The sample covers the period 2017-2021, including the COVID-19 pandemic crisis period. Our key finding shows that the performances were similar given the parent indices are viewed as market benchmarks suggesting positive investor's surpluses for ESG motivated investors in the high volatile regime. If parent indices are not regarded as market benchmarks, there are many ESG indices are underperformed during the crisis. Nevertheless, there are only two indices deteriorated by the crisis in our sample. There are more ESG indices result in positive investor's surplus during the crisis.

[5876] *BETWEEN CRISES AND OPPORTUNITIES: IDENTIFYING PATTERNS IN THE FLOW OF PASSENGERS AND TOURISTS IN BRAZIL BETWEEN 1993 AND 2021*

Socrates Jacobo Moquete Guzmán (Universidade Estadual de Santa Cruz) and Roque Pinto (Universidade Estadual de Santa Cruz).

To understand the variation in local responses to events of global magnitude, it is essential to consider the structural peculiarities that characterize each country. In this sense, this article aims to verify the dynamics of air passenger traffic and the arrival of tourists through the three access routes in Brazil, from the perspective of uncertainties and fluctuations arising from the social, political and economic environment of the country and worldwide. The article presents data on national and international air traffic of passengers arriving at Brazilian airports, as well as the arrival of tourists to Brazil. And it makes the connection with the occurrence of major events and economic and political crises at national and international level. It is considered that the contribution of this article lies in developing a qualitative analysis from the statistical data presented in a relatively long time interval, which may allow predicting patterns or even testing explanatory models. Thus, in order to verify how the crises affected the sector's performance, a historical series of 29 years was prepared based on official statistics from government agencies in Brazil and international organizations such as the UNWTO. The presented results indicate that, despite the increase in tourist traffic in the first decade of the 21st century, the Brazilian market still performs below capacity due to persistent and severe economic and social disparities and political and economic uncertainties. In the Brazilian context, the historical series of passenger air traffic and tourist arrivals between 1993 and 2021 points to some evidence, among them, that domestic events affect these flows of passengers and tourists more than international crises. More specifically, the intersection of several variables made it possible to verify that air passenger traffic in Brazil seems to be much more susceptible to internal vicissitudes than to systemic contagious crises at the international level.

[5887] *IMPROVING THE ACCURACY OF FIRM FAILURE FORECASTING USING NON-FINANCIAL VARIABLES: THE CASE OF CROATIAN SME*

Tamara Kuvek (No institution), Ivica Pervan (Faculty of Economics, Business and Tourism, University of Split) and Maja Pervan (Faculty of Economics, Business and Tourism, University of Split).

Firm failure modeling has been an important research topic for many years, both for academia and practitioners in banks, investment funds, and other institutions. Namely, firm failure often has a wide range of negative effects for numerous subjects, especially for employees, investors, creditors, and suppliers. Every new economic crisis like Global Financial Crisis (2007-2008), Great Recession (2008-2012) or the recent COVID-19-caused economic crisis (2020) brings this issue into the spotlight again. There is a large body of literature dealing with firm failure from different perspectives, however, the main goal of almost all papers is to design a prediction model with the lowest possible forecasting error. Early studies (Beaver, 1967, Altman, 1968, Deakin, 1972, etc.) put focus on the use of financial indicators in the prediction of firm failure. Given that financial indicators are based on financial statements, such studies explore the usefulness of accounting information in the context of crediting decisions and firm failure modeling. As a general conclusion of early studies, as well as many recent studies (Lukason & Laitinen, 2019, Svabova et al. 2020, Smiti & Soui, 2020, Crespi-Cladera, 2021, etc.), one can point out the finding that financial indicators are useful in predicting business failure. However, studies that analyzed the predictive power of financial indicators over time showed that as the accounting data ages (t-2, t-3...), the predictive power of financial indicators declines sharply. The accuracy of the forecasting over a long period directly depends on the stationary of the data, which implies a stable correlation between the variables in the forecast period. Empirical research has shown that this is difficult to achieve, which is emphasized by Du Jardin & Severin (2011), who analyzed 34 studies and determined that the accuracy of the model decreases by 15% in 3 years before the bankruptcy. Pervan et al (2019) report similar findings in a more recent study. To improve the predictive power of forecasting models, some authors (Argenti, 1984; Altman et al. 2008; Gudmundson, 2002; Pervan & Kuvek, 2013; Laitinen, 2013; Altman et al. 2016; Habachi & Benbachir, 2019, etc.) started using non-financial variables. The general finding from most of the mentioned studies is that the inclusion of non-financial indicators in addition to financial indicators improves the accuracy of predicting firm failure. This can be explained by the characteristics of qualitative variables that do not vary over time (or only partially change) and achieve more stable correlations as compared to financial variables. Previous papers as a set of non-financial variables often use firm age, firm size, industry, and region since these data are publicly available. A unique data set obtained from a Croatian commercial bank, that encompassed data for 4.639 Croatian SMEs in the period 2011-2015, is used in this paper. Therefore, this research is one of the few whose modeling includes non-financial variables such as manager's experience, regularity in settling obligations, export, and degree of diversification. An important element in firm failure modeling is the definition of the dependent variable, i.e. firm failure variable. In countries such as Croatia, where bankruptcies are opened at the very late stage of the failure process and where the percentage of receivables collection in bankruptcy is quite low, it is much more useful to predict the early stage of firm failure than bankruptcy. Therefore, the total sample of SMEs is divided into three categories depending on the bank's internal credit rating and regularity in the settlement of due obligations. The group of successful firms includes only those firms that have an intact high credit rating and that have not had any delays in settling their

obligations. A firm entered the sensitive category (early stage of firm failure) if it had a reduced credit rating and a delay in meeting obligations for a duration between 30 and 90 days. Finally, the firm was classified as failed if it had the lowest credit rating with delays in the settlement of obligations longer than 90 days, accompanied by a recorded amount of loss for the bank. Empirical findings based on a bivariate logistic regression model (successful and failed firms) indicate that by adding non-financial indicators into the model based on financial variables, the accuracy of forecasting increases significantly. Namely, the total classification error decreases by an average of 26,99%, while the AUROC value increases by an average of 7,33%. In the additional model, the dependent variable – firm failure was grouped into three categories: successful, sensitive, and failed firms. Particular interest was in the sensitive firms' category because it is interesting to investigate whether entering the early stage of firm failure prediction can be forecasted with the proposed set of financial and nonfinancial variables. The estimated multinomial logistic regression model indicates that one financial variable (self-financing) and three non-financial variables (orderly payment of obligations, export, and age of the company) significantly explain the occurrence of the early stage of firm failure. Our study adds to the existing literature in several ways. Firstly, we develop a unique set of nonfinancial variables to explore how much these variables can improve firm failure forecasting. Secondly, we develop a model for the prediction of the early stage of the firm failure process, which enables timely decision-making in order to avoid credit losses. Finally, we conduct research for the sample of Croatian SMEs for which this kind of modeling is almost nonexistent. In addition to confirming the theoretical assumptions about the usefulness of non-financial variables, the designed model also has the possibility of practical use, especially in commercial banks.

[5904] *Global forecasting models: Normalization methods for heterogeneous time series panel data*

Oskar Triebe (Stanford University), Leonie Freisinger (Stanford University) and Christoph Bergmeir (Monash University).

Global Forecasting Models (GFMs) learn a single set of shared parameters across multiple time series, so-called panel data. In this way, they can benefit from the relatedness between time series. GFMs recently gained traction thanks to their gain in accuracy compared to their univariate counterparts.

GFMs perform better than univariate models as the data pooling from multiple time series allows fitting a more complex model without overfitting. Their success is subject to the assumption that all series (in the panel data) originate from the same data source and therefore are inherently similar [1]. In other words, such models implicitly assume the underlying panel dataset to be homogeneous. However, in real-world applications, panel data is often heterogeneous. Heterogeneity in panel data can be observed in multiple ways: (1) There can be heterogeneity between the individual time series (inter-series), e.g. in different characteristics, such as mean, variance, or length. (2) Heterogeneity can also be observed within a single time series (intra-series) when its characteristics vary over time, e.g. heteroscedasticity, structural breaks, or intermittency [2]. Heterogeneity in either dimension invalidates the homogeneity assumption for GFMs. The combination of multiple sources for heterogeneity is a multifaceted issue and hence more complex to analyze. Normalization is a common solution for such problems by transforming the data to a common scale or distribution of values [3]. However, normalizing panel data is not trivial.

Adequate normalization of panel data depends on the dataset characteristics and the nature of the prediction task. Even the basic case of inter-series scale heterogeneity with no intra-series issue is not as trivial as it appears. With the goal of homogenizing panel data, normalization transforms data to a common scale or distribution of values. It, therefore, discards the original scale and distribution information, which might be relevant to the prediction and training of a GFM. If the prediction task is concerned with the absolute values of each series, it becomes crucial to incorporate scale information in the normalization scheme. In turn, incorporating global scale information could be disadvantageous for prediction tasks concerned with relative values, as it may inhibit cross-learning. Hence, normalization is challenging because we need to find the right balance between normalizing across series and maintaining the original information of each series relative to the other series. A more challenging case of panel data heterogeneity is the addition of intra-series heterogeneity. Normalization methods that tackle intra-series heterogeneity exist for univariate time series. However, GFMs further require addressing inter-panel heterogeneity. When both, inter-series and intra-series heterogeneity are present in panel data, normalizing across series and within a series are interdependent. This duality makes the normalization of heterogeneous panel data complex, and choosing a normalization scheme that finds the "global optimum" is a difficult task.

Previous work has contributed various approaches to time series normalization. For single time series, established normalization methods [4] such as Min-Max Normalization or Mean Normalization are commonly used. Approaches such as Instance Normalization or Batch Normalization address the intra-series heterogeneity. For homogenous panel data

with time series of high similarity, the aforementioned normalization methods also achieve satisfactory performance. To address the challenges of heterogeneous panel data, different approaches tackling specific sub-challenges have been developed. Kim et al. [5] tackle panel data with intra-series heterogeneity, specifically time series with a changing mean and variance over time. They propose Reversible Instance Normalization (RevIN), a method that introduces an affine neural network layer with learnable parameters to be fitted jointly with the GFM. While this approach can maintain the original scale information by re-transforming the series, it does not use the original scale information in the normalization scheme itself. Hence its performance on prediction tasks where the absolute values matter is limited. Passalis et al. [6] propose to address inter-series heterogeneity with Global Adaptive Input Normalization (GAIN). It also contains learnable parameters. In contrast to RevIN, the approach can incorporate the original scale information. Therefore, it combines the global statistics with the local statistics for a selected range of the panel data in an affine neural network layer which learns the normalization parameters. Despite existing approaches to normalize heterogeneous panel data, popular GFMs such as Informer [7] and NBEATS [8] rely on simpler normalization methods.

Currently, there is no universal normalization approach for GFMs that addresses all described challenges regarding heterogeneous panel data. Further, it is not clear which of the available normalization approaches to use for a specific use case. In our work, we motivate the importance of adequate normalization for GFMs. We investigate which methods are best suited for normalizing heterogeneous panel data. Hereby, we evaluate their adequacy for the underlying prediction task based on global and individual time-series characteristics. We further quantitatively analyze their trade-offs regarding different prediction tasks. Finally, we contribute a systematic overview of normalization methods for panel data and provide recommendations for common use cases with best practices and common pitfalls.

References: [1] Bandara, K., Bergmeir, C., & Smyl, S. (2020). Forecasting across time series databases using recurrent neural networks on groups of similar series: A clustering approach. Expert systems with applications, 140, 112896. [2] Hewamalage, H., Ackermann, K., & Bergmeir, C. (2023). Forecast evaluation for data scientists: common pitfalls and best practices. Data Mining and Knowledge Discovery, 37(2), 788-832. [3] Salles, R., Belloze, K., Porto, F., Gonzalez, P. H., & Ogasawara, E. (2019). Nonstationary time series transformation methods: An experimental review. Knowledge-Based Systems, 164, 274-291. [4] Bhanja, S., & Das, A. (2018). Impact of data normalization on deep neural network for time series forecasting. arXiv preprint arXiv:1812.05519. [5] Kim, T., Kim, J., Tae, Y., Park, C., Choi, J. H., & Choo, J. (2021). Reversible instance normalization for accurate time-series forecasting against distribution shift. In International Conference on Learning Representations. [6] Passalis, N., & Tefas, A. (2020, December). Global adaptive input normalization for short-term electric load forecasting. In 2020 IEEE Symposium Series on Computational Intelligence (SSCI) (pp. 1-8). IEEE. [7] Zhou, H., Zhang, S., Peng, J., Zhang, S., Li, J., Xiong, H., & Zhang, W. (2021, May). Informer: Beyond efficient transformer for long sequence time-series forecasting. In Proceedings of the AAAI conference on artificial intelligence (Vol. 35, No. 12, pp. 11106-11115). [8] Oreshkin, B. N., Carpov, D., Chapados, N., & Bengio, Y. (2019). N-BEATS: Neural basis expansion analysis for interpretable time series forecasting. arXiv preprint arXiv:1905.10437.

[5909] *Intrinsic Explainable Self-Enforcing Networks using the ICON-D2-Ensemble Prediction System for Runway Configurations*

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Weather forecasts are indispensable for the decision on the direction of operation of a runway system. Since the forecasts contain uncertainties, additional challenges arise for runway configuration management (RCM). With developments in machine learning, numerous models have been developed to improve forecasts and assist management. In this contribution, an intrinsic explainable Self-Enforcing Network (SEN) is presented as a decision support system for the RCM at Frankfurt Airport.

[5936] *Intelligent models for friction failures forecasting using acoustic time series: challenges, current status and future prospective*

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: Friction failures is the main cause of severe damage in industrial mechanical systems. The repair of the dam-aged parts
is a tangible economic burden for developed countries with yearly costs of billions dollars. Friction monitoring promises
the early detection and even forecasting of upcoming failures, thus providing the decision time to avoid the damage.
However, the challenge of such developments is the complex nature of friction dynamics, stipulated by multiple physical
phenomena involved. This work is the retrospective overview on several cutting edge monitoring techniques based on
the analysis of acoustic time-series, generated by real systems. Our work involves machine learning (ML) for detection
and forecasting of different friction abnormalities. The limit of the standard ML towards friction monitoring is discussed
and several solutions are proposed to enhance the performance of existing algorithms. First, the specialized features are
presented, providing robust detection and short-term forecasts of failures. Secondly, the merge of diffusion models and
ML is shown as an improvement of long – term forecasts and even the parts life-time. The background numerical
mechanisms of both developments are disclosed with respect to the underlying friction phenomena. All our methods are
scalable and ensure the continuous monitoring throughout the entire duration of the mechanical part/system lifetime.
The prospective for the future friction computational developments is discussed with respect to the limits of existing
monitoring achievements.

[5966] *Forecasting transitions in digital society: From social norms to AI applications*

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München).

The use of AI and digitalization in many areas of everyday life holds great poten-tial but also introduces significant
societal transitions. This paper takes a closer look at three exemplary areas of central social and psychological relevance,
which might serve as a basis for forecasting transitions in the digital society: (1) social norms in the context of digital
systems, (2) surveillance and social scoring, and (3) artificial intelligence as a decision-making aid or decision-making
authority. For each of these areas, we highlight current trends and developments and then present future scenarios that
illustrate possible societal transitions, related questions to be answered, and how such predictions might inform
responsible technology design.

[5978] *Forecasting inflation in turbulent environment. The case of Poland and Ukraine*

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Business) and Olena Motuzka (National Academy of Statistics, Accounting and Audit).

This paper investigates inflation forecasts of professionals and consumers in Poland and Ukraine, between 2016 and
2022. We aim to test inflation expectations when forecasts are made in highly uncertain environment. The National Bank
of Ukraine (NBU) and the National Bank of Poland (NBP) declare to conduct monetary policy under inflation targeting
regime. These policy framework acknowledges the pivotal role of inflation expectations (private forecasts) for policy
effectiveness and assessment. There are several strategical, institutional, and operational arrangement, that ensure the
focus on expectations, like: independence, transparency, priority given to stabilising inflation, nominal anchors, and no
exchange rate commitment. Since decades, inflation targeting has been perceived to be the optimal policy framework,
grounded in theoretical premises. However, the strategy and its ability to stabilise inflation and drive inflation
expectations of economic agents have recently been questioned. The increase in global and domestic risk and uncertainty
affected inflation rates. In line with the inflation increase, the change in inflation forecast proprieties might occur. This
paper investigates whether the change can be captured in time series properties.   The study covers Ukraine, which is the
central point of our discussion. The economy under Russian military aggression has been facing extraordinary conditions
for one year. Nonetheless, the National Bank of Ukraine performs its activities. The role of the NBU changed dramatically,
with the price stability mandate losing its priority in favour of more general macroeconomic stabilisation and more room
for a closer cooperation with the government. Expectations formation during the invasion is the most important
perspective of this study. The second economy we study is chosen for two reasons: (1) Poland is a neighbouring country
that is indirectly affected by the invasion, (2) longer experience of the NBP in stabilising inflation and managing inflation

expectations could constitute the benchmark for this study. The research period of this work covers seven years; we use monthly data provided by central banks or national statistical offices. Four years, 2016-2019, create a benchmark period for the expectations properties. They represent the period considered normal for monetary policy conduct – the deflation episode vanished in 2016, and the pandemic shock did not occur yet. For practical reasons, we cannot extend the benchmark period by the end of 2021 as global inflation increased in mid-2020 with the increase in oil and food prices. The increase was accompanied by post-pandemic consequences, such as supply disruptions and the rapid expansion of many economies supported by monetary and fiscal policy. Even if we are more interested in expectations formation during the war, the paper discusses the pandemic and invasion period jointly. Two time series of inflation forecasts for each economy are tested: consumer inflation expectations and professionals expectations. First, we test for the expectations rationality (unbiasedness, macroeconomic efficiency). Non-rationality of expectations opens room to study errors multi-dimensionally: we examine forecast errors, homogeneity of expectations and their dependencies (forecast-encompassing tests). We are also interested in a possible switch towards greater forward-lookingness of expectations during this turbulent time. The tests are run for individual country levels. Previous papers identified the change of expectations properties during the rough time. Preliminary results suggest that the proprieties of expectations have also changed this time - since 2020 when compared to previous period. Both consumes and professionals are more forward-looking. However, they do not provide more accurate forecasts. The drivers of expectations errors are rooted in increasing inflation rates and energy prices. We are aware that the method applied does not allow us to conclude on causality. Nonetheless, this study is the first attempt to discuss the features of inflation forecasts during such a particular period in two economies of our interest. When longer time series are available, more complex policy analysis will be available.

[6012] *On time-dependent cointegration with two examples*

Guy Mélard (Université libre de Bruxelles).

Recent advances on cointegration were reviewed by Tj\o stheim~(2020). This contribution is a follow-up to Alj et al.~(2017) and Alj et al.~(2022), where VARMA models with time-dependent (tdVARMA) coefficients are studied. Time-varying cointegration was already treated by Kapetanios et al.~(2020) but not using the tdVARMA approach. In Alj et al.~(2022) are even considered coefficients that depend on the time series length n on the basis of Azrak and M\'elard (2021). Then the model is called tdVARMA$^{(n)}$. In both cases, the model coefficients are supposed to depend on a small number of parameters. These papers contain the asymptotic theory of the quasi-maximum likelihood (QML) estimators. Under a few assumptions, these estimators are consistent and asymptotically normal. In the present contribution, time-dependent cointegration is considered. This is done by starting from a time-dependent extension of an error correction model (ECM), possibly dependent on n, denoted tdECM$^{(n)}$. Generalizing Mauricio~(2006), see also M\'elard et al.~(2006), the tdECM$^{(n)}$ is expressed as a tdVARMA$^{(n)}$ model on the differenced series. Hence, the original parameters of the tdECM$^{(n)}$ can be estimated by using a QML estimation method with the algorithm of Alj et al.~(2016). The asymptotic theory is applicable, with the usual changes due the unit roots, and its assumptions can be checked a posteriori. A first example taken from L\"utkepohl~(2005) is treated. A second example on the US interest rates taken from the literature (Reinsel and Ahn, 1992), will illustrate the talk: a time-dependent cointegration relation exists and is statistically significant.

[6051] *Optimising the determinants of liquidity risk: UAE's Emirates Islamic Bank*

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In this study, we analyse the principal parameters affecting the liquidity risk incurred by the Emirates Islamic banking system. The study examines annual data from Emirates Islamic bank in the UAE. Information is from their annual activity reports and financial results. A multiple linear regression model is used to assess the impact of eleven bank-specific variables on the liquidity risk of Emirates Islamic bank. The model showed that ROA and NPL negatively affect the bank's liquidity risk, and the econometric model created for the Emirates Islamic bank study proved insignificant. Thus, our empirical results add to the existing research on the determinants of liquidity risk incurred by Emirates Islamic banks operating in the UAE.

[6062] *Metaheuristic-based forecasting approach for planning and dimensioning 5G and beyond Telecommunication Networks*

Mohamed Ouwais Kabaou (University of Gabes), Nesrine Zoghlami (University of Tunis El Manar) and Mohamed Fayech (University of Gabes).

Abstract. The subject of this paper is the planning and dimension- ing of new generation networks, which are essential tasks in forcasting telecommunication network installations. The process of planning and dimensioning reflects the strategy of telecommunication operators in selecting how to implement processing entities. As a result, modern intelligent techniques, including artificial intelligence, deep-learning and machine-learning, as well as heuristic and metaheuristic approaches, have become the focus of current research in forecasting telecommunication networks. The objective of this research is to guarantee and improve operational efficiency while ensuring a satisfactory quality of service.

[6117] *Application of artificial intelligence methods for predicting the compressive strength of green concretes with rice husk ash*

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To encourage sustainable growth and minimize the greenhouse effect, rice husk ash can be used in place of a certain amount of cement. The research models the impact of using rice ash as a substitute for regular Portland cement on the compressive strength of the concrete. This study examines various machine-learning techniques and provides a procedure for determining the optimal model. A database of 909 examined samples is the foundation for creating forecast models. The derived models are assessed using the RMSE, MAE, MAPE, and R accuracy criteria. According to research, artificial intelligence techniques can be used to create models for the compressive strength of concrete with acceptable accuracy. It is also possible to assess the significance of specific input variables and their influence on the strength of such concrete.

[6152] *Assessing the climate change on the Tuzla-Nuntasi Basin, Romania*

Gabriel Dobrica (Ovidius University of Constanta), Carmen Maftei (Transilvania University of Brasov) and Alina Barbulescu (Transilvania University of Brasov).

Drought is a real problem with an impact on any economic sector, ecological systems, and especially on the quality of human life. Such events are frequent in the last period. The Dobrogea region is one of the most affected zones of Romania. Such an example is the event on August 20, 2020, in the Nuntași hydrographical basin, when the Nuntași-Tuzla lake completely dried up. Such events have been more frequent in Romania during the last decade. Therefore, in this article, we analyze the Nuntași-Tuzla lake zone through the viewpoint of the climatic and hydrological parameters that led to a hydrological drought of such severity. The monthly precipitation, temperatures, and evapotranspiration registered for 60 years, together with the flow series of the river that feeds the Nuntași Lake form the database of the actual study. We analyze the correlation between these variables and present the hydrological balance, which can be used to further forecast the study region's climate evolution.

[6154] *Interest Rate Sensitivity of the largest European Pharmaceutical Companies. An Extension of The Fama and French Five-Factor Model*

Maria De La O Gonzalez Perez (University of Castilla-La Mancha) and Francisco JareÑo CebriÁn (University of Castilla-La Mancha).

This paper analyses the sensitivity of the ten largest European pharmaceutical companies' returns to variations in nine explanatory factors during the period between June 2004 and January 2020. Specifically, this work estimates, using the quantile regression (QR) approach, an extension of the five-factor model of Fama and French (2015) to which Carhart's

(1997) momentum and momentum reversal risk factors, Pastor and Stambaugh's (2003) liquidity factor and the long-term nominal interest rate have been added. The aim of using this regression technique is to check whether the sensitivity of the returns of these pharmaceutical companies is affected by the state of the economy, so the results will be subjected to a robustness test, which will divide the sample period into three scenarios: pre-crisis, crisis and post-crisis. The main results determine that the most influential factors in explaining the performance of the main European pharmaceutical companies are the three factors of the original Fame and French model plus the asset investment factor. Furthermore, as expected, this extended model of Fame and French shows greater explanatory power in the lower and higher quantiles, showing a U-shaped pattern in all the periods analysed and reaching its maximum value in the crisis period. Therefore, all this shows the suitability of the quantile regression (QR) approach for the estimation of the model, since its explanatory power is more relevant in the extreme quantiles, related to extreme stages of the economy. Finally, the sensitivity of the top ten European pharmaceutical companies to changes in risk factors is higher in extreme market conditions.

[6155] *Club classification of foreclosures rates in Spain*

Rafael González-Val (Universidad de Zaragoza & IEB) and Miriam Marcén (Universidad de Zaragoza).

In this paper, we study the evolution of the Spanish foreclosures rates (defined as the number of judicial foreclosures per 1,000 inhabitants) across the 50 Spanish provinces (NUTS III regions) during the period 2001(Q1) to 2019(Q4), using a cluster algorithm. This methodology allows us to determine the existence of foreclosures convergence among the Spanish provinces. We use the Phillips and Sul (2007, 2009) panel convergence method. Phillips and Sul (2007, 2009) develop a cluster procedure based on a log t–test, which focuses on the evolution over time of idiosyncratic transitions in relation to the common component. The method of Phillips and Sul concentrates on the evolution over time of foreclosures rates relative to the average, rather than on individual foreclosures rates by province. Thus, their methodology enables us to identify the relative transitions that occur within subgroups, and to measure these transitions against the correlative of a common trend (Phillips and Sul, 2009). The convergence method does not require specific assumptions concerning the stationarity of the foreclosures rate, our variable of interest, and/or the existence of common factors. In addition, the nonlinear form of the model proposed by Phillips and Sul (2007, 2009) is sufficiently general to include a wide range of possibilities in terms of time paths and their heterogeneity. This cluster algorithm has recently been used in the economic literature, for instance, to explore convergence in the cost of living across US cities (Phillips and Sul, 2007, 2009), price convergence (Fischer, 2012), the historical population convergence of US cities (González-Val and Lanaspa, 2016), the income convergence of member states of the European Union (Fritsche and Kuzin, 2011; Bartkowska and Riedl, 2012), outcome convergence within the US (Choi and Wang 2015), and even the happiness club convergence in Europe (Apergis and Georgellis, 2015), among others. We add to this literature by exploring whether foreclosures rates converge across Spanish provinces. Results show that the Spanish province-level foreclosures rates do not converge in only one conver-gence club; rather, we identify ten foreclosures convergence groups when all the period is considered. Nevertheless, during this period there was a major negative shock, the global financial crisis in 2008. As a consequence, there was a dramatic increase in foreclosures in all regions. The main governmental response to this crisis was an important change in legislation, the legal reform passed in 2012 to protect mortgage debtors. Under the new regime, it is difficult for low-income debtors who meet certain requirements to be evicted. To explore the possible effects of these events, we split the sample in two sub-periods (pre-crisis, 2001(Q1)–2008(Q4), and post-crisis, 2009(Q1)–2019(Q4)). We observe strong differences in the number of groups and their composition when using the entire sample and the post-crisis period. Surprisingly, in the post-crisis period no club classification is obtained, as all provinces are classified in the same club. Therefore, there were different paths across regions before the crisis, but after the shock foreclosures rates in all provinces converged to the same path. Supplementary analysis of the possible factors related to the club classification in the pre-crisis period is carried out. Furthermore, the cluster analysis is also applied to the loans rate (defined as the number of mortgage loans per 1,000 inhabitants) for the period 2007(Q1) to 2019(Q4). This time data is only available for the post-crisis period. Results support convergence in loans rates within six convergence clubs, pointing to six different loans rate patterns across the Spanish regions.

[6160] *Advanced hyperparameter optimization of deep learning models for wind power prediction*

Shahram Hanifi (university of Glasgow), Hossein Zare-Behtash (university of Glasgow) and Andrea Cammarano (university of Glasgow).

The uncertainty of wind power as the main obstacle to its integration into the power grid can be addressed by an accurate and efficient wind power forecast. There are various methods to improve the performance of forecasting models. Machine learning algorithms as widely used wind power forecasting methods, it can be achieved by tuning their hyperparameters. Common hyperparameter optimization methods such as grid search or random search are time-consuming, computationally expensive, and unreliable for complex models such as deep learning neural networks. Therefore, there is an urgent need for automatic methods to discover optimal hyperparameters for higher accuracy and efficiency of prediction models. In this research, three advanced hyperparameter optimization techniques including Scikit-opt, Optuna, and Hyperopt are utilized to tune the hyperparameters of Convolutional Neural Network (CNN) and Long Short-Term Memory Network (LSTM) models that are employed for short-term wind power forecasting of an offshore wind turbine in Scotland. The impact of the hyperparameter optimization methods on the accuracy and efficiency of the CNN and LSTM models are assessed by comparing the root mean square error (RMSE) of the predictions and the required time to tune the models. The results show that the Optuna algorithm, using a Tree-structured Parzen Estimator (TPE) search method and Expected Improvement (EI) acquisition function, has the best efficiency for both CNN and LSTM models. Regarding the accuracy, it is demonstrated that while for the CNN model, all the optimization methods perform almost the same, the LSTM model optimized by the Hyperopt algorithm, based on the annealing search method, results in the highest accuracy. In addition, to investigate the impact of the random initialization feature of neural networks on the prediction performance of the forecasting models, the proposed structures for deep learning models were examined to determine the most robust structure with less sensitivity to the randomness.

[6165] *Changes in growth volatility in MERCOSUR countries: is there evidence of decoupling of the Uruguayan economy?*

Bibiana Lanzilotta (Instituto de Economía, Facultad de Ciencias Económicas, UdelaR - Centro de Investigaciones Económicas), Gonzalo Zunino (Centro de Investigaciones Económicas - Facultad de Ciencias Económicas, UdelaR) and Rafael Mosteiro (Centro de Investigaciones Económicas).

This paper explores the existence of structural changes in the cycle volatility of economic growth of the MERCOSUR countries between 1980 and 2019 and explores the hypothesis of the decoupling of the Uruguayan economy. The empirical analysis follows the procedures originally applied in McConell & Pérex-Quiroz (2000) and Stock & Watson (2002; 2003). The results show that Brazil has a break in cycle volatility in the mid-1990s, Argentina shows a structural break in the year 2010, and Uruguay presents a structural break after the economic crisis of 2002. Both in Uruguay and Brazil, cyclical volatility was reduced by about 50% in the pre-and post-bust periods. Meanwhile, in Argentina, the reduction in volatility is less significant. Focusing on the case of Uruguay, results show that even controlling for external and regional volatility breaks remain. These results rule out that the observed reduction in volatility responds exclusively to a less unstable external context ("good luck hypothesis") in the case of one of the smaller MERCOSUR countries.

[6167] *But… What Is The Poverty Rate Today? Testing Poverty Nowcasting Methods in Latin America and the Caribbean*

German Caruso (The World Bank), Leonardo Lucchetti (The World Bank), Eduardo Malasquez (The World Bank), Thiago Scot (The World Bank) and Andres Castaneda (The World Bank).

Poverty estimates usually lag behind two years, which makes it difficult to provide real-time poverty analysis to assess the impact of economic crisis and shocks among the less well-off, and subsequently limits policy responses. This paper takes advantage of up-to-date average economic welfare indicators like the gross domestic product per capita and comprehensive harmonized micro data of more than 180 household surveys in 15 Latin American countries. The paper tests three commonly used poverty nowcasting methods and ranks their performance by comparing country-specific and regional poverty nowcasts with actual poverty estimates for 2003-14 period. The validation results show that the two bottom-up approaches, which simulate the performance of each agent in the economy to nowcast overall poverty, perform relatively better than the top-down approach, which uses welfare estimates to explain the performance of poverty at an aggregate level over time. The results are robust to additional sensitivity and robustness tests.

[6251] *Short-term Polar Motion Forecast Based on the Holt-Winters Additive Algorithm and Angular Momenta of Global Surficial Geophysical Fluids*

Jiesi Luo (Hubei Luojia Laboratory, School of Geodesy and Geomatics, Wuhan University, Wuhan), Zihan Pan (School of Geophysics and Geomatics, China University Of Geosciences, Wuhan) and Wei Chen (Hubei Luojia Laboratory, School of Geodesy and Geomatics, Wuhan University, Wuhan).

By taking into account the variable free polar motion (PM) known as the Chandler wobble (CW) and irregular forced PM excited by quasi-periodic changes in atmosphere, oceans and land water (described by the data of effective angular momenta EAM), we propose a short-term PM forecast method based on the Holt-Winters (HW) additive algorithm (termed as the HW-VCW method, with VCW denoting variable CW). In this method, the variable CW period is determined by minimizing the differences between PM observations and EAM-derived PM for every 8-year sliding timespan. Compared to the X- and Y-pole forecast errors (ΔPMX and ΔPMY) of the International Earth Rotation and Reference Systems Service (IERS) Bulletin A, our results derived from operational EAM can reduce ΔPMX by up to 38.4% and ΔPMY by up to 34.3% for forecasts ranging from 1 day to 30 days. Further, we prove that using EAM forecast instead of operational EAM in the HW-VCW method can achieve similar accuracy.

[6277] *Sustainable Development of Renewable Energy Consumption in G7 and ASEAN-5 Countries: Panel Fixed Effect Econometric Modelling*

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Energy is the key driver of economic growth, however, the economic leadership position of G7 countries and the rising global manufacturing hub status of the ASEAN-5 countries have yet to achieve the Sustainable Development Goals. Thus, this paper aims to examine the effects of real GDP per capita, urban population, the number of individuals using the internet, carbon dioxide emissions, total trade and net foreign direct investment (FDI) inflows on the renewable energy consumption (REC) of G7 and ASEAN-5 countries from 1990 to 2021. Using Studenmund and Gujarati & Porter procedures of the panel data model, the panel fixed effect econometric modelling held the best outcome for both the G7 and ASEAN-5 countries' REC models. Based on the findings, the urban population highly and positively affects REC in the G7 countries. However, there is also a positive and strong relationship between net FDI inflows and REC in the ASEAN-5 countries. The empirical findings proved the importance of macroeconomic, socioeconomic and environmental variables in affecting the outcomes of REC policies across both developed and developing countries.

[6374] *Slope Entropy Characterisation: Adding another interval parameter to the original method*

Mahdy Kouka (Department of System Informatics and Computers, Universitat Politècnica de València, 03801 Alcoy, Spain) and David Cuesta-Frau (Technological Institute of Informatics, Universitat Politècnica de València, 03801 Alcoy, Spain).

Slope Entropy (SlpEn) is a recently proposed time series en- tropy estimation method for classification. This method has yielded bet- ter results than other similar methods in all the published studies so far. It is based on a signal gradient thresholding scheme using two parame- ters, δ and γ, in addition to the usual embedded dimension parameter m. In this work, we investigated the possibility of adding one thresholding parameter more, termed θ, and we compared the original method to the new one. The experiments results showed a small improvement using the new method in terms of classification accuracy. However, the temporal cost increased significantly and therefore we concluded it is not worth the extra effort unless maximum accuracy is of utmost importance.

[6440] *Impact of Dynamic Closure Gates on storm surge levels in Barnegat Bay, NJ during Hurricane Sandy.*

Gregory Slusarczyk (US Army Corps of Engineers), Mary A. Cialone (US Army Corps of Engineers) and Robert Hampson (US Army Corps of Engineers).

The in-depth, purely theoretical study presented in this paper includes numerical modeling and analysis of the effects of Dynamic Closure Gates (DCGs) on water levels in Barnegat Bay, New Jersey during Hurricane Sandy. In particular, the

analysis of the sensitivity of back-bay water levels to DCG operational decisions such as how far in advance of the storm to close a gate to mitigate back-bay flooding induced by the storm surge and when to reopen the gate to release water from the bay is investigated.

Barnegat Bay, Manahawkin Bay, and Little Egg Harbor are hydraulically connected and form the largest bay system in New Jersey (over 326 km2). The DCGs were numerically implemented across two New Jersey inlets serving this system: Barnegat Inlet and Little Egg/Brigantine Inlet, which connect this bay system with the Atlantic Ocean. Several closure combinations with respect to the timing of closing/re-opening the gates were investigated and the results were compared with a Base Condition (the inlets fully open) and a Static Closure Gate condition (the inlets closed for the entire simulation time). The storm event, Hurricane Sandy, was numerically simulated for all inlet closure combinations utilizing the ADvanced CIRCulation hydrodynamic model (Luettich et al. 1992). The following closure criterion was applied: Barnegat and Little Egg/Brigantine Inlet closed 2 hours before the 50% of the annual exceedance probability (AEP) water level was reached and re-opened after the storm passed on the falling tide when the head difference at the gates is less than 1 ft. This is referred to as the short closure scenario. The long closure scenario implements the closed gates at low tide 6 to 12 hours before the storm arrives and reopens them about 12 hours after the short closure when the storm has moved on and the head differential is less than 1 ft.

The importance of the timing and duration of implementing dynamic closure gates examined in this paper has implications on reduction in back bay flooding due to: 1) the volume of water prevented from entering the bay, 2) the volume of water not being trapped behind a static gate, and 3) a reduction in the height of seiche with a smaller volume of water in the bay. Not examined, but also of importance, is the potential reduction in environmental impacts by using a dynamic rather than a static closure gate.

Luettich, R. A., Westerink, J.J., and Scheffner, N. W. (1992). ADCIRC: An advanced three-dimensional circulation model for shelves, coasts, and estuaries. Technical Report DRP-92-6, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

[6517] *Functional Profile Methods for Structured Missing Not at Random Data*

Matus Maciak (Charles University, Prague), Ivan Mizera (University of Alberta, Edmonton) and Michal Pesta (Charles University, Prague).

One of the most fundamental tasks in non-life insurance, done on regular basis, is risk reserving assessment analysis, which amounts to predict stochastically the overall loss reserves to cover possible claims. The most common reserving methods are based on different parametric approaches using aggregated data structured in the run-off triangles, which contain missing not at random elements. Here, we propose a rather non-parametric approach, that handles the underlying loss development triangles as functional profiles and forecasts the claim reserve distribution through permutation bootstrap. Three competitive functional-based reserving techniques, each with slightly different scope, are presented; their theoretical and practical advantages -- in particular, effortless implementation, robustness against outliers, and wide-range applicability -- are discussed. Theoretical justifications of the methods are derived as well. An evaluation of the empirical performance of the designed methods and a full scale comparison with standard (parametric) reserving techniques are carried on several hundreds of real run-off triangles against the known real loss outcomes.

[6527] *Leveraging Temporal Patterns in Forecasting*

Thomas Schincariol (Trinity College Dublin), Thomas Chadefaux (Trinity College Dublin) and Hannah Frank (Trinity College Dublin).

Do patterns in sequences of events repeat across temporal and spatial units? And if so, how can we leverage those temporal patterns in forecasting? Temporal patterns in data emerge naturally based on interactions between different actors, as discussed in various disciplines, such as epidemiology, ecology and social sciences. On the micro-level, humans detect patterns by observing their environments, which informs individual decision-making. In this paper, we introduce a novel method, which serves to extract patterns from time series data and includes the gained information when forecasting. More specifically, we apply techniques from time series clustering, such as k-Means and Dynamic Time Warping, to find shapes in time series data and corresponding cluster assignments, which serve as dynamic covariates. Three model versions are constructed–a purely autoregressive model, an autoregressive model with static covariates, and an autoregressive model with static and dynamic covariates. We validate the proposed method using empirical time series data, and demonstrate that dynamic covariates improve prediction accuracy. This method is applicable to a range

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of problems, including autoregression, regression and classification, and different data types, such as migration flows, deaths in armed conflict, and counts of protest events.

[6543] *Forecasting Pakistan's GDP Growth with Leading Indicators: A MIDAS Approach*

Tanweer Islam (National University of Sciences and technology) and Sidra Tahir (National University of Sciences and technology).

This study aims to forecasts the quarterly GDP growth rates for Pakistan using leading macro-economic indicators covering a period from January 2002 to December 2020. We use Mixed Data Sampling (MIDAS) regressions, which directly links the quarterly observations with the high-frequency monthly indicators without any aggregation techniques and compare the forecasting performance of MIDAS with the conventional Autoregressive Distributed Lag (ARDL) model. The main purpose of this study is to test the power of leading indicators in providing early estimates of quarterly GDP growth rates. The forecast horizon covers all the 4 quarters of the annual year 2020. The forecast evaluation criteria to compare the forecast of these models are RMSE, MAE, MAPE and Theil Inequality Coefficient. Diebold Mariano Test is also conducted to statistically check the forecasting accuracy of two models. Our results show that, MIDAS performs better than the benchmark model, the ARDL. Among the MIDAS variants considered in this study, U-MIDAS turns out to be the best option for forecasting.

[6562] *Analysis of long-term effects of the restrictions on trade with Russia using the TEMOA-Europe energy system optimization model*

Daniele Lerede (MAHTEP Group, Department of Energy "Galileo Ferraris", Politecnico di Torino, Turin, Italy), Gianvito Colucci (MAHTEP Group, Department of Energy "Galileo Ferraris", Politecnico di Torino, Turin, Italy), Valeria Di Cosmo (Department of Economics and Statistics "Cognetti de Martiis", Università degli Studi di Torino, Turin, Italy), Matteo Nicoli (MAHTEP Group, Department of Energy "Galileo Ferraris", Politecnico di Torino, Turin, Italy) and Laura Savoldi (MAHTEP Group, Department of Energy "Galileo Ferraris", Politecnico di Torino, Turin, Italy).

In the framework of political tools supporting decision-making, energy system optimization models allow the analysis of the role of currently available and innovative energy technologies in different scenarios. In response to the pressing issue of climate change, Europe has committed to becoming the first carbon-neutral continent by 2050 in the context of the application of the European Green Deal. In addition to that, the present situation of profound changes in the geopolitical chessboard after Russia's invasion of Ukraine led to the approval of the REPowerEU Plan. It is a strategy intended to end the dependence on Russian fossil fuels and to enhance clean energy production and diversification of the supply. This work aims at analyzing the set of energy and environmental policies related to the European Green Deal and the REPowerEU Plan using TEMOA-Europe over a time scale up to 2050. TEMOA-Europe is an open-software and open-database energy system optimization model representing the European network of supply and demand technologies under a set of different macroeconomic assumptions. Results are obtained in terms of optimal configuration of the energy system under exam and the related CO2 emissions to show the long-term impact of the Green Deal and the REPowerEU measures.

[6625] *Long Lead ENSO Forecast using Adaptive Graph Convolutional Recurrent Neural Network*

Jahnavi Jonnalagadda (George Mason University) and Mahdi Hashemi (George Mason University).

El Niño-Southern Oscillation (ENSO), a natural phenomenon in the Pacific Ocean, is caused by cyclic changes in sea surface temperature (SST) and the overlying atmosphere in the tropical Pacific. The impact of ENSO varies depending on its phase (warm/cold), strength, and duration, ranging from slightly warmer or colder temperatures to extreme weather events such as flash floods, droughts, and hurricanes, affecting various regions around the globe. Therefore, forecasting ENSO is crucial in climate science. Previous studies have demonstrated poor ENSO forecasting performance for lead times exceeding one year either due to inadequate input feature representation or the interpolation of missing SST values for land points to create a uniform/grid input that is suitable for training deep learning models such as Convolutional Neural Networks (CNNs). This study addresses these issues by presenting input features mainly SST and upper oceanic heat content in a proper spatial and temporal format and designing an Adaptive Graph Convolutional Recurrent Neural Network (AGCRNN) that can handle non-uniform/non-grid input for forecasting ONI for lead times up to 18 months. In AGCRNN, the graph learning module learns the spatial structure of features adaptively during training, while the graph

convolution in hidden layers of recurrent neural network captures temporal relationships of features with ONI. Experiments conducted on simulation and reanalysis datasets demonstrate the superiority of AGCRNN compared to state-of-art statistical and dynamical models for forecasting ONI.

[6636] *Using the Cramér-von Mises test statistic to examine the effectiveness of cryptocurrencies*

Aktham Maghyereh (United Arab Emirates University) and Mohammad Al Shboul (University of Sharjah).

The paper examines whether cryptocurrency informational efficiency is affected by the COVID-19 pandemic crisis and the Russian-Ukrainian war (R-U). Using the Cramér-von Mises test statistic (CvM), our results show evidence of weak efficiency in cryptocurrencies, but with heterogeneous levels of efficiency across currencies. This means that cryptocurrency prices are less predictable, and an arbitrage opportunity is very limited in these markets. Our study also reports that the degree of efficiency evolves over time. During extraordinary events, our analysis shows that almost all cryptocurrencies, except Ethereum Classic and Ripple, tend to be less efficient. The COVD-19 crisis shows higher degrees of inefficiency compared to the R-U war. This pattern can be seen not only during the COVID-19 breakout and the Russian-Ukrainian war but also during periods of high political tension and trade war, such as the conflict between the US and North Korea and the US-China trade war in the middle of 2017 and early 2019, as well as during the Bitcoin crash in early 2018. This paper serves as a useful source of information for investors, governments, prudential regulatory authorities, and portfolio diversification.

[6682] *Forecasts of the mortality risk of COVID-19 using the Markov-switching autoregressive model: A case study of Nigeria*

Idowu Ayodeji (Obafemi Awolowo University, Ile-Ife, Nigeria).

Background: Nigeria is one of the countries that have begun to ease COVID-19 protocols; however from all indications the fight is far from being over. According to Nigeria Centre for Disease Control (NCDC), the three variants of Omicron, BA4, and BA5 are still very dominant in the country. The question on the lips of health expert is whether or not Nigeria is at the verge of the fifth wave. Currently there are 255,244 confirmed cases and 3,142 deaths. This study models daily fatality rate in Nigeria and forecasts future occurrences using Markov switching model (MSM). Results: MSM estimates segmented fatality rates into three states of low-, medium- and high-risks. Further, estimates revealed that Nigeria is currently at the low-risk regime in which 1 (CI: -1, 1) person, on the average, is expected to die of coronavirus daily; however, based on the entire dataset from March 23, 2020 to March 19, 2022, the most probable scenario in Nigeria in the nearest future is the medium-risk in which 4 (CI: -3, 10) persons, on the average, die of coronavirus daily with 48.7% probability, followed by the low-risk with 39.6% probability, and lastly the high-risk in which 9 (CI: -10, 27) persons, on the average, die of coronavirus with 11.8% probability. Conclusion: These results indicate that the government's current interventions and policies are yielding desired results; however, the likelihood of returning to the medium-risk state is still high. Thus there is need for caution in the quest to liberalize the economy to ensure that Nigeria remains at the low-risk zone till the virus is eventually eradicated.

[6750] *Medium Term Horizon Time Photovoltaic Power Generation Prediction for an Island Zone*

Harry Ramenah (Université de Lorraine), Camel Tanougast (Université de Lorraine), Nidhal Rezg (Université de Lorraine) and Abdel Khoodaruth (University of Mauritius).

This article presents the predetermined Johansen long term relation- ship of dataset from a photovoltaic (PV) plant to predict the power output to an island zone. The goal is the prediction using Johansen model of the PV power generation in the island of Mauritius. In this article, time series using on-site measurements dataset have been used to design an original predicting model, the Johansen model for PV power output. This model is trained to predict random monthly, weekly and daily PV power output upon different seasons and years. The experimental results demonstrate that the Johansen model is a powerful me- dium-term predicting tool.

[6760] *Moving Object Path Prediction in Traffic Scenes Using Contextual Information*

Jaime Boanerjes Fernandez Roblero (Insight SFI Research Centre for Data Analytics, Dublin City University), Suzanne Little (Insight SFI Research Centre for Data Analytics, Dublin City University) and Noel E. O'Connor (Insight SFI Research Centre for Data Analytics, Dublin City University).

Moving object path prediction in traffic scenes from the perspective of a moving vehicle allows to improve safety on the road which is the aim of Advanced Driver Assistance Systems (ADAS). However this task still remains a challenge. Work has been done on using x,y positional information of the moving objects only. However, beside positional information there is more information that surrounds a vehicle that can be leveraged in the prediction along with the x,y information. This is known as contextual information. In this work, a deep exploration of these features is done by evaluating different types of data, using different fusion strategies. The core of the model used are CNN and LSTM architectures.

[6770] *Analyzing the Business Cycle Properties and Its Relationship with Electricity Consumption and Temperatures in Mexico*

Vicente German-Soto (Universidad Autonoma de Coahuila) and Ruth Bordallo Favela (Universidad Autónoma de Coahuila).

This research estimates the co-movement, persistence, and volatility of the business cycle, electricity consumption, and temperature in Mexico over 2002.1-2019.4 period. Theoretically, the consumption of electrical energy is directly related to economic development and temperature. The greater the volume of economic activity, the greater the demand for electrical energy. Also, in regions with extreme temperature conditions a greater electricity supply is demanded. However, this relationship is not uniform, as it is affected by seasonal temperature factors. That is, in extreme seasons (winter and summer) consumption is accentuated because there is also greater fluctuation of the electricity supply. The X-13 ARIMA technique is used to decompose the quarterly time series into cycle and trend, after that, the cyclical component is used to estimate the properties of co-movement, volatility, and persistence. The co-movement between two variables is measured by the correlation coefficient and it informs about if some variable is pro-cyclical, acyclic or countercyclical. Persistence is a measure of the duration of cycle fluctuations, and it is measured by the first-order autocorrelation coefficient. We find that electricity consumption is pro-cyclic to the business cycle, but maximum and minimum temperatures are countercyclical, while the greater volatility is for the link between minimum temperature and the business cycle, so extremely cold climates are a greater risk factor than hot climates, with substantial effects on economic development and electricity consumption. The duration of fluctuations (persistence) are not significant, a reasonable result because seasonality of the temperatures. Conclusions suggest some policy recommendations to address future electricity demand.

[6854] *Data-driven spatio-temporal modelling and optimal sensor placement for digital twin set-up.*

Mandar Tabib (SINTEF), Adil Rasheed (SINTEF), Kristoffer Skare (NTNU) and Endre Bruaset (NTNU).

Accurate and faster modelling of temporal dynamics of key variables, and their control are important for enabling a computationally-efficient predictive digital twin of a small-scale Greenhouse. This involves involving efficient predictive models and optimal measurements in the digital twin. For faster modelling, we develop a Long-short term memory (LSTM) and Unsupervised Proper orthogonal decomposition (POD)-based reduced order model. The LSTM-POD model is predicting the temporal evolution of temperature and velocity fields for our digital twin case, and the predictions are similar to those obtained from Hi-fidelity numerical models. For efficient measurements, we seek to employ optimal number of sensors and their locations are identified by use of Dynamic mode decomposition (DMD)-based QR pivoting technique. These tools have potential in enabling forecasting and monitoring of key variables.

[7004] *Time-Frequency varying estimation of Okun Law a wavelets-based approach*

Roman Mestre (Université de Montpellier, MRE).

In this study we analyze the Okun Law coefficient in the time-frequency space for the Eurozone. The main objective is to study the robustness of the Okun Coefficient across time while analyzing the effect of economic cycles. We use a time-frequency approach to estimate time-frequency varying okun coefficient. We note that the commonly acceptable range for okun coefficient set at 0.3 0.5 is only valid for long run cycles (4-6 years cycles) as for short run cycles the coefficient is

more volatile. In addition, the Wavelets Phase indicate that leading variable is also changing depending to economic conditions.

[7008] *Measuring the impact of climate transition risk in the systemic risk: a multivariate quantile-located ES approach*

Laura Garcia-Jorcano (Universidad de Castilla-La Mancha) and Lidia Sanchis-Marco (Universidad de Castilla-La Mancha).

In this paper, we study the effect of climate change risk effects on systemic risk in different scenarios. Unlike the 2008-2009 financial crisis or COVID-19, climate change risks that can result in a systemic crisis fall into two specific categories: physical risks and transition risks. Transition risks differ from the physical risks that threaten the global economy. The anticipation and the mitigation of the transition risks are crucial to ensuring the smooth and successful progress of the transition. For this reason, we focus on transition risk effects on systemic risk, i.e., the financial loss that a bank institution may incur, directly or indirectly, due to adjusting to a low-carbon economy, which can affect the global system. The efforts to incorporate climate transition risks into regulatory frameworks face important challenges because capturing climate risk properly requires assessing it over long horizons and using new methodological approaches so that prudential frameworks adequately reflect actual risks. So, how do quantify the transition risk effects on systemic risk? This question is very important to understand the impact of climate change on financial systems. There is no consensus about this concern in the literature. We contribute to answering the question by analyzing the resilience of banking institutions to different transition risk scenarios. The main aim is to measure the impact of the transition risk of the banks to systemic risk using a new climate transition systemic risk measure called Delta Climate Transition at Systemic Risk (DeltaCT-at-SR) based on the Delta quantile-located multivariate conditional CARES (DeltaQLMVCo-CARES) measure from Garcia-Jorcano and Sanchis-Marco (2021), which is the extreme downside risk or tail risk in terms of the Expected Shortfall (ES) of the system should both the financial system and the institution simultaneously be in distress in a climate stress scenario. This systemic risk measure estimation is coherent, informative, efficient, and consistent as we use conditional autoregressive ES (CARES) models and estimate the cross volatility and quantile effects of individual institutions and global system simultaneously using multivariate multi-quantile conditional autoregressive ES (MVMQ-CARES) model. Hence, DeltaCT-at-SR allows us to quantify the effect of green and brown bank indices according to different transition risk scenarios on systemic risk during several periods including the COVID-19 crisis. To that end, we characterize the behavior of bank index returns conditional on the dynamics of market returns for green and brown assets, reflecting low and high vulnerability, respectively, to transition to a low-carbon economy. For this purpose, we work with European, US, and China banking institutions over the period 2010-2022 and construct green and brown bank indices based on their carbon risk score (CRS).

We consider four climate transition scenarios coherent with the network for greening the financial system (NGFS) narrative: hot house world, disorderly transition, and two orderly transitions, featured in terms of relative changes in green and brown index returns (see Ojea-Ferreiro, Reboredo, and Ugolini, 2022 for more details). We then assess the systemic risk impact of those scenarios on banking indices in terms of the average return below that minimum threshold using conditional autoregressive expectile (CARE) models for expectiles at 1% and 99% significance levels for green and brown indices. As a preliminary study, we estimate the univariate CARE model for the system at the 1% significance level and bivariate CARE models for the system and green or brown bank indices for two significance levels, 1% and 99%. Next, we estimate quantile-located multivariate conditional CARES (QLMV-CoCARES) for the different climate transition scenarios, considering different bank indices and significance levels according to each scenario. From these estimations, we calculate DeltaCT-at-SR as the difference between QLMV-CoCARES in the climate transition scenario and QLMV-CoCARES in the benchmark (without considering the climate transition scenario) in percentage terms. Finally, for the last period of the sample (2017-2022), we forecast our measure DeltaCT-at-SR for the four scenarios proposed and disentangle the contribution of the market risk and the climate risk to the systemic risk.

The main contribution of this paper is the provision of a climate transition systemic risk measure, DeltaCT-at-SR, based on the DeltaQLMVCo-CARES measure from Garcia-Jorcano and Sanchis-Marco (2021). This measure allows us to quantify the effect of different transition risk scenarios on systemic risk during several periods including the COVID-19 crisis for green and brown banks. Other contributions are as follows. First, we provide losses and profit measures using CARE models from the simplest to the most complex ones which incorporate transition risk by using green and brown banks returns according to CRS ranking scores, evaluating the impact of the different variables via parameter estimates. Second, for an out-of-sample period, which includes the pre-COVID and COVID-19 periods, we provide a forecast of our measure DeltaCT-at-SR for the different transition risk scenarios, analyzing the role of transition risk and COVID-19 pandemic in

the systemic risk. Finally, we disentangle the contribution of the market risk and the climate transition risk to the systemic risk under the different transition risk scenarios.

The main results are, i) from the estimation analysis, the CARE model that captures more systemic risk is the disorderly model, whereas the CARE model with less risk is the orderly model, ii) from the estimation and forecasting analysis, DeltaCT-at-SR measure is higher in periods of distress, especially in hot house world and disorderly scenarios, iii) the mean profits of brown banks are the main source of systemic risk in the scenario of low transition risk cost (hot house world), iv) the highest spillover effects are in hot house world scenario during the COVID-19 period, and v) regarding the different components of systemic risk, the climate transition risk component is higher in the disorderly scenario for estimation and forecasting analysis. In summary, the inclusion of green and brown extreme risk together in the systemic risk measure captures more systemic risk and more spillover effects in the disorderly scenario in the estimation and forecasting analysis.

This paper is related to two streams of literature. First, recent studies on systemic risk and climate change, such as Jung, Engle, and Berner (2021), Choudhury (2021), Furukawa, Ichiue, and Shiraki (2020), the ECB report (2021), Litterman (2020), and Benedetti et al. (2021). We add to the literature by quantifying the contribution of the climate-related tail risk of banks on systemic risk. Despite the evidence that banks price climate risks, our measure suggests that climate change could substantially increase systemic risks when transition risks rise sharply depending on the risk transition scenario. In this sense, our paper is more closely related to the recent literature that analyzes the impact of climate-related risks on financial systems such as Battiston, Dafermos, and Monasterolo (2021). More closely related to our study is Ojea-Ferreiro, Reboredo, and Ugolini's (2022) systemic risk metrics computed from a copula-based model of dependence between financial firm returns and financial asset market returns. Our paper goes beyond this as we provide a comprehensive climate systemic risk measure based on ES computed from expectiles regression in the spirit of the recent systemic risk measure developed by Garcia-Jorcano and Sanchis-Marco (2021). The advantages of our climate systemic risk measure are, i) using ES computed from CARE models, modeling directly and linking it to the market risk, being more robust to outliers, and more efficient measure, whose inference is much easier than with quantiles, and distribution-free avoiding model risk, ii) considering cross spillover effects from system to brown and green banks, and vice-versa in different scenarios, iii) disentangling the total systemic risk between market risk and climate transition risk components, and iv) providing a forecasting analysis, jointly stochastic dominance analysis. And second, our paper is related to recent literature focusing on COVID-19 and systemic risk finance, for example, Duan et al. (2021), Borri and Giorgio (2021), and Bevilacqua et al. (2021). It is relevant to study how the pandemic may impact the resilience of banking. Our paper contributes to this concern by examining bank systemic tail risk during the COVID-19 crisis. Furthermore, studying the nexus between COVID-19 and climate change is also relevant. There are two main research gaps in assessing the financial impacts of the pandemic and climate change. The first gap regards the understanding of how adjustments in bank lending in the aftermath of the shock affect firms' investment decisions and the implementation of the government's recovery policies (see, among others, Monasterolo and Battiston, 2020). The second gap, in several countries, COVID-19, did not happen in isolation but is compounded by climate change physical and transition risks (Phillips et al., 2020). With climate change on the rise (IPCC, 2021), the compounding of shocks could become more frequent in the future (see more details on Dunz, Naqvi, and Monasterolo, 2021, and Philips et al., 2019). Given the few existing studies on the impact of climate change on systemic risk, this paper is a meaningful attempt to research systemic risk from the perspective of climate change, thereby extending the boundary of studies on financial risks in the banking sector and enriching empirical research on climate change, systemic risk, and the COVID-19 crisis.

Therefore, our measure could be a very useful tool for regulators and financial system actors to measure and forecast the transition risk effects on systemic risk in the most dangerous scenarios. As the recent United Nations Climate Change Conference of the Parties (COP26, COP27) states, the financial system may be unprepared to assume these transition risks such as rapid shifts in policies and regulations, the need to develop low-carbon technologies, and changes in consumer behavior and investor preferences. As demonstrated by our systemic risk measure, these risks can destabilize the financial system.

[7064] *A Comparison between successive Estimate of TVAR(1) and TVAR(2) and the Estimate of a TVAR(3) Process*

Johannes Korte (University of Bonn), Jan Martin Brockmann (University of Bonn, Institute of Geodesy and Geoinformation, Theoretical Geodesy) and Wolf-Dieter Schuh (University Bonn, Geodesy and Geoinformation).

In time series analysis auto regressive (AR) modelling of zero mean data is widely used for system identification, signal decorrelation, detection of outliers and forecasting. An AR process of order p is uniquely defined by p coefficients and the variance of the noise. The roots of the characteristic polynomial can be used as an alternative parametrization of the

coefficients, which can be used to construct a continuous covariance function of the AR process or to verify that the AR process is stationary. In a previous study we introduced AR process of time variable coefficients (TVAR process) in which the movement of the roots was specified as a polynomial of order one. Until now, this method was analytically derived only for TVAR processes of order one and two. Thus, higher-level processes had to be assembled by successive estimation of these process orders. In this contribution the analytical solution for a TVAR(3) process is derived and compared to the successive estimation using a TVAR(1) and TVAR(2) process. We will apply the proposed approach to a GNSS time series and compare the best-fit TVAR(3) process with the best-fit composition of TVAR(2) and TVAR(1) process.

[7068] *Precipitation Time Series Analysis and Forecasting for Italian Regions*

Ebrahim Ghaderpour (Sapienza University of Rome), Hanieh Dadkhah (Sapienza University of Rome), Hamed Dabiri (Sapienza University of Rome), Francesca Bozzano (Sapienza University of Rome), Gabriele Scarascia Mugnozza (Sapienza University of Rome) and Paolo Mazzanti (Sapienza University of Rome).

In Italy, most of destructive landslides are triggered by rainfalls, particularly in the central Italy. Therefore, effective monitoring of rainfalls is crucial in hazard management and ecosystem assessment. Global precipitation measurement (GPM) is the next-generation satellite mission which provides the precipitation measurements worldwide. In this research, we employed the available monthly GPM data to estimate monthly precipitations for the twenty administrative regions of Italy from June 2000 to June 2021. For each region, we applied the non-parametric Mann-Kendall test and its associated Sen's slope to estimate the precipitation trend for each calendar month. In addition, for each region, we estimated a linear trend and seasonal cycles of precipitations by the antileakage least-squares spectral analysis and showed the annual precipitation variations using box plots. Lastly, we compared machine learning algorithms based on auto-regressive moving average for monthly precipitation forecasting. The findings of this research provide a significant insight into processing climate data both in terms of trend-season estimates and forecasting and can potentially be used in landslide susceptibility analysis.

[7079] *EFFECT OF REAL EXCHANGE RATE ON PER CAPITA REAL GROSS DOMESTIC PRODUCT IN PAKISTAN: A TIME SERIES ANALYSIS*

Sakina Bibi (SBBWUP) and Khadija Shams (SBBWUP).

Exchange rates are the main indicator that influences the price of products and services that affect the level of transaction on international trade and capital movement between countries. This study aims to analyze effect of real exchange rate on real GDP per capita in Pakistan. The real exchange rate plays a significant role in growth of the economy because it leads to increase in export via stabilizing currency value at any particular level. In this study, time series data from 1981 to 2019 is used. Augmented Dickey Fuller (ADF) test is used to estimate the unit root problem in the data. Linear regression model is applied on stationary data. The empirical result determines that real exchange rate has a negative impact on real GDP per capita. While financial capital and inflation have a positive effect on real GDP per capita in Pakistan. The R^2 value implies that the explanatory variables explained about 62% systematic variation on per capita real GDP over the observed years while the remaining variation is explained by the other variables outside the model. Ramsay reset test shows the model is correctly specified. Correlation matrix shows that Inflation and the real exchange rate are negatively correlated. Therefore, country with a consistently lower inflation rate exhibits a rising currency value, as its purchasing power increases relative to other currencies. The most important policy implication from the findings indicates that there is a need for an exchange rate policy framework that complements the existing inflation targeting regime in Pakistan.

[7215] *Measuring extremal clustering in time series*

Marta Ferreira (Centro de Matemática, Universidade do Minho).

The propensity of data to cluster at extreme values is important for risk assessment. For example, heavy rains that last over time lead to catastrophic floods. The extremal index is a measure of Extreme Values Theory that allows measuring the degree of high values clustering in a time series. The extremal index estimation implies the definition of sensitive tuning parameters in the efficiency of different existing methodologies. In this work we propose an algorithm that avoids these constraints. Performance will be evaluated based on simulation. We also illustrate with real data.

[7230] *CLASSICAL HURST EXPONENT VS. DYNAMIC HURST : A STUDY OF THE IMPACT ON SUBPRIME AND COVID-19 CRISES ON THE EFFICIENT AFRICAN STOCK EXCHANGES*

Oumou Kalsoum Diallo (Dr à la Faculté des Sciences Economiques et de Gestions Université Cheikh Anta DIOP de DAKAR) and Pierre Mendy (Pr. Faculté des Sciences Economiques et de Gestions Université Cheikh Anta DIOP de DAKAR).

Today, the stock market plays an essential role in modern economies. It allows savings to be channeled into the most profitable investments, which assumes that the market functions efficiently. However, we have witnessed a succession of stock market crises or crashes. In addition, there are various anomalies in the financial markets. All these observations constitute factors that call into question the theory of efficiency. Consequently, the question of the efficient financial markets has resurfaced and reopened the debate. In addition, the African financial sphere has been growing steadily over the last few decades and is becoming more and more important. As such, studying the behavior of these exchanges seems necessary. Thus, we will make a comparative study by testing the efficiency of these exchanges first with the classical Hurst exponent. This tool allows us to characterize the structure of the market, but can also be interpreted as a measure of the degree of imperfection or market inefficiency; it will be estimated by the wavelet approach. Since financial markets are often confronted with periods of crisis that lead to their instability, it would be interesting to analyze their behavior during such events. Thus, we will study the impact of the subprime and covid-19 crisis on these African financial markets. This analysis will be done using the dynamic Hurst exponent, which allows us to take into account the time-varying market efficient. The results can be summarized as follows: first, the Hurst index H(q) highlights the multifractal character of the African stock markets and the rejection of the null hypothesis of no memory for all series of returns. The results also show that the two crises have impacted these markets differently; contagion is faster for covid-19 than subprimes crisis. They also reveal that during periods of crisis, most African stock exchanges alternate between periods of efficiency and inefficiency.

[7250] *The Influence of Solar Activity on Snow Cover over the Qinghai–Tibet Plateau and Its Mechanism Analysis*

Yan Song (China Meteorological Administration Training Center), Zhicai Li (Shanxi Climate Center), Yaqing Zhou (Jinzhong Meteorological Bureau of Shanxi Province), Xunqiang Bi (Institute of Atmospheric Physics, Chinese Academy of Sciences), Tiangui Xiao (School of Atmospheric Sciences, Chengdu University of Information Technology) and Ziniu Xiao (Institute of Atmospheric Physics, Chinese Academy of Sciences).

Using global ocean vertical temperature anomaly data, we identified that a significant response of the sea temperature anomaly (STA) to the solar radio flux (SRF) exists. We found that the STA exhibited a significant correlation with Asian summer and winter precipitation, among which the response from the Qinghai–Tibet Plateau (the QTP) was particularly noticeable. Based on NCEP/NCAR reanalysis data, the latent heat flux (LHF) anomaly, which plays a key role in winter precipitation in China, especially over the QTP, showed a significant response to the SRF in the Pacific. The results demonstrated the bottom-up mechanism of impact of solar activity (SA) on the plateau snow through sea–air interaction. Meanwhile, a top-down mechanism was also present. When the SRF was high, the stratospheric temperature in the low and mid-latitudes increased and the temperature gradient pointed to the pole to strengthen the westerly wind in the mid-latitudes. The EP flux showed that atmospheric long waves in the high altitudes propagated downward from the stratosphere to the troposphere. A westerly (easterly) wind anomaly occurred in the south (north) of the QTP at 500 hPa and the snowfall rate over the QTP tended to increase. When the SRF was low, the situation was the opposite, and the snowfall rate tended to decrease. The model results confirmed that when total solar irradiance (TSI) became stronger (weaker), both of the solar radiation fluxes at the top of the atmosphere and the surface temperature over the QTP increased (decreased), the vertical updraft intensified (weakened), and the snowfall rate tended to increase (decrease) accordingly. These conclusions are helpful to deepen the understanding of SA's influence on the snow cover over the QTP.

[7254] *Time Series Forecasting Case Study on Risk-based Asset Integrity Management for Low Voltage Failures of Power Distribution Systems*

Sakura Attanayake (University of Stavanger, Norway) and R.M. Chandima Ratnayake (Department of Mechanical and Structural Engineering and Materials Science, University of Stavanger).

The concept of risk assessment is an important tool in asset integrity management of power distribution systems. This manuscript presents a risk-based asset integrity management (RBAIM) methodology for the optimization of power distribution assets using a time series analysis approach. This approach deals with the time series forecasting on risk assessment for low voltage level (400/230V) failures using Python programming language considering historical low voltage (LV) fuse failure data from a case study starting from 2019 over 44 months. The proposed approach is deployed in a power distribution utility located in a densely populated area of Colombo district, Sri Lanka. The authors proposed a methodical approach for the identification of priority components for asset maintenance and repair ranking based on the risk index percentage value to enhance the predictiveness of potential defects and estimate the risk of potential failures. The results show that the proposed time series forecasting methodology for RBAIM is useful for power distribution utility asset owner organizations for continuous monitoring, evaluation of asset conditions, and implementation of proper maintenance and repair strategies to enable assets to perform at their optimal level. The proposed RBAIM methodology enables practicing engineers to assure the asset integrity of power distribution utilities.

[7259] *Does competition contribute to stability? - empirical evidence from the European Union banking sector*

Candida Ferreira (ISEG, Universidade de Lisboa, UECE and REM).

This paper empirically tests the two competing hypotheses regarding the relationship between competition and stability: the competition-fragility hypothesis and the competition-stability hypothesis. The banking sector stability is first proxied by the estimated Z-score that provides a measure of overall bank stability. Further, the paper separately considers some specific constituent components of the Z-score measure to analyse different aspects of the bank stability: bank profitability and bank capitalisation. Two different measures are used to represent bank competition: the Herfindahl-Hirschman Index (a specific measure of market concentration), and the Boone indicator (which measures competition from an efficiency perspective). Using data sourced from the Moody's Analytics BankFocus database, the paper applies panel estimations to a relatively large panel including 784 relevant banks of all the 27 European Union countries, between 2006 and 2021. The main findings overall confirm the validity of the competition-fragility hypothesis. Moreover, the results obtained for two specific EU countries: Germany and France, highlight some specific differences in particular regarding the effects of bank market concentration, and the responses to the crises that affected the EU banking institutions over the considered period. The findings of this paper reinforce the relevance of the policy makers' role and give room to some recommendations.

[7299] *Modelling High-dimensional Time Series with Nonlinear and Nonstationary Phenomena for Landslide Early Warning and Forecasting*

Hangfei Zheng (The University of Melbourne), Guoqi Qian (The University of Melbourne) and Antoinette Tordesillas (The University of Melbourne).

Landslides are nonstationary and nonlinear phenomena often recorded as high-dimensional vector time series manifesting spatiotemporal dependence. Contemporary econometric methods use error-correction cointegration (ECC) and vector autoregression (VAR) to handle the nonstationarity but ignore the nonlinear trend. Here we improve the ECC-VAR methodology by inserting into the model a nonlinear trend c(t) and nonparametrically estimating it by penalised maximum likelihood, and name the improved method ECC-VAR-c(t). Assisted by the empirical dynamic quantiles (EDQ) dimension reduction technique, it is sufficient to apply ECC-VAR-c(t) to just a small number of representative EDQ series to surmise the whole dataset. The performance of ECC-VAR-c(t) is assessed by using a real-world slope dataset that consists of 1803 time series, each having 5090 time states. In addition to the forecast values, we also provide three risk assessments to predict locations, time and risk of a future failure with quantified uncertainty for building an early-warning system.

[7337] *Comparison of strategies for multi-step ahead wind power forecasting*

Shahram Hanifi (University of Glasgow), Hossein Zare-Behtash (University of Glasgow) and Andrea Cammarano (University of Glasgow).

Accurate multi-step ahead wind power forecasting is challenging and of great interest to both academia and industry. Several strategies have been presented in the literature to address this complex problem, but there is still no

comprehensive comparison between different strategies. To fill this gap, in this study, by reviewing the existing strategies, three main approaches including the Recursive, direct, and multi-input multi-output (MIMO) strategies are investigated for multi-step ahead wind power prediction of two wind turbines in Turkey and Scotland. A hybrid prediction method based on the application of the Isolation Forest for outlier treatment, Long short-term memory (LSTM) as the core of the prediction model, and a new hyperparameter optimization algorithm for tuning of the LSTM model is used for predictions in different strategies. The results of the experiments indicate that (1) in three-step ahead wind power forecasting for both turbines, using the direct strategy achieves the best accurate forecast. (2) By increasing the forecasting horizon to 6 steps, using the direct strategy achieves the best accurate forecast only for the Scottish wind turbine, but for the Turkish turbine, MIMO strategy obtains better results. This difference is attributed to the presence of more outliers in the Scottish wind turbine. (3) Using the Recursive strategy for both forecast horizons and both wind turbines leads to the worst forecast accuracy.

[7413] *Bayesian forecasting algebraic algorithm for forecasting non-Gaussian air contaminated material after an accident.*

Ali Gargoum (Associate Professor, UAE University).

In the Gaussian model given in Smith et al. (1995), used for predicting air concentration after a nuclear accident, it is natural to assume that the distribution of observations conditional on their states is non-normal (e.g., Poisson or lognormal). The states are the quantities of mass under puff and fragments of contamination where puffs are emitted stochastically from a chimney and directed by a known wind-field across space. The Markovian property of the stochastic emission process and deterministic fragmentation process, means that the joint distribution of mass fragments at any time is decomposable with its small clique dimension in a Bayesian network. In this work, I propose an approximate algorithm for quick Bayesian inference in non-Gaussian dynamic systems (the lognormal case) based on the dynamic generalized linear models when used on junction trees. The algorithm validity can be checked numerically- for example by using the Hellinger distance metric.

[7414] *Projections of the climate change impact on the sea state conditions of the Black Sea*

Liliana Rusu ("Dunărea de Jos" University of Galati).

The wave climate responds to global climate variability and such changes in the sea state conditions are very important, considering their substantial impact on the coastal environment, maritime transport, and offshore activities. Nowadays, dynamical projections provide the impact of climate changes on the surface winds, which are driven by various emission scenarios consistent with the Representative Concentration Pathways (RCPs), [1]. These wind fields are then used to force the wave models, implemented at global or regional scales, in order to provide projections of the sea state conditions until the end of the 21st century. By comparing the historical and future results, an overview of how the wave climate is expected to be affected by climate change is obtained.

The target area of this study is the Black Sea, a semi-enclosed basin characterized in general over extended areas by mean values of the significant wave height of around 0.9m, [2]. However, extreme events are often present especially in winter, when the significant wave height can reach values even more than 10m, [3]. Furthermore, in recent years, these extreme events seem to be present more frequently, being also characterized by a greater duration and intensity.

In this context, the objective of the present study is to evaluate the wave climate over the recent past (1976-2005) based on the hindcast and historical data obtained from the simulations performed with the SWAN (Simulating WAves Nearshore, [4]) model forced with wind fields at 10m over the sea level. For the hindcast simulations, SWAN model is driven by ERA5 (abbreviation of the European Center for Medium-Range Weather Forecasts reanalysis, fifth generation) wind fields, while for the historical simulations, the wave model is forced with high resolution wind fields provided by a Regional Climate Model (RCM), namely CNRM-ALADIN63 [5]. RCMs data, both for historical and future periods, were produced in the framework of the EURO-CORDEX experiment [6], and they are distributed free in the public domain via the Earth System Grid Federation (ESGF) and Copernicus database.

For the present work, the projections of the wave climate corresponding to the near future, the 30-year interval 2041-2070, are considered for evaluation and comparison with the recent past. Thus, based on the same wave modelling system as in the recent past simulations, the near future sea state conditions were simulated. In this case, to force the wave model projections of the wind fields provided by CNRM-ALADIN63 under RCP4.5 scenario are used. For the near future period, the simulation results of the Black Sea wave climate show a slight enhancement in terms of average values of the significant wave height.

[7489] *Assessing the Effect of Co-production on Education Quality*

Hanane Azemzi (université Ibn Zohr) and El Houssaine Erraoui (université Ibn Zohr).

Co-production, as the involvement of service users in the design and delivery of public services, has gained the attention of researchers and policy makers over the last decade. Despite the growing body of research but there is still a need for a methodological diversity to test the assumptions about the effects of co-production. The aim of this paper is to investigate to what extent co-production practice increase quality in educational services from citizens' perspective. The data, for this study, were collected through survey questionnaire on a sample of 79 members of parents' associations in Morocco and were analyzed using partial least squares structural equation modeling (PLS-SEM) method. The results showed that co-production activities has a positive effect on education quality in terms of improving parents-school relationship, students' knowledge acquisition, learning environment, learning materials and infrastructure.

[7500] *Assessing the Accuracy of Directional Forecasts*

Constantin Burgi (University College Dublin).

This paper extends existing tests for assessing the accuracy of directional forecasts. The extensions allow assessing the accuracy for a variety of new loss functions like squared prediction errors and have substantially superior size adjusted power if the data is serially correlated in a certain way. For more general serial correlation, the extensions perform better in small samples than existing tests. The new tests are then applied to the categorical EUR/USD forecasts in the ifo-Institute's World Economic Survey and to the point forecasts for quarterly GDP in the Philadelphia Fed's Survey of Professional Forecasters. We are able to pinpoint that while there is profitability and predictive accuracy in some cases, a simple time-series model is not beaten and that the GDP forecasts have predictive value up to two quarters ahead.

[7505] *Analysis of Fermi-LAT blazar lightcurves in the time domain using Singular Spectrum Analysis*

Alba Rico Rodríguez (Universidad Complutense de Madrid), Alberto Domínguez (Universidad Complutense de Madrid), Pablo Peñil (Clemson University), Sara Buson (Julius-Maximilians-Universität), Marco Ajello (Clemson University), Margherita De Toma (Julius-Maximilians-Universität) and Sagar Adhikari (Clemson University).

Blazars are galaxies with supermassive black holes that have relativistic jets pointing towards Earth. These astronomical sources are characterized by emission over the whole electromagnetic spectrum and variability at different time scales from seconds to years. Finding patterns in this variability has shown to be rather difficult due to observational and data analysis challenges. Yet, some blazars have been found to have periodic emissions, which may be explained for instance by the existence of a binary supermassive black hole. This hypothesis is intriguing and further investigations are necessary. In this work, we will apply for the first time a singular spectrum analysis (SSA) to the search of blazars periodicity utilizing data from the Large Area Telescope on board NASA's Fermi Gamma-ray Space Telescope. We find that SSA performs significantly better than previous methods used for the identification of periodicity and other trends allowing us to increase by a factor of two the number of known blazars showing periodicity.

[7595] *Uncertainty and Business Cycle: an empirical analysis for Uruguay*

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As a small and open economy, Uruguay is highly exposed to international and regional shocks that affect domestic uncertainty. To account for this uncertainty, we construct two geometric uncertainty indexes (on the base of industrial expectations survey about the economy and the export market) and explore their association with the Uruguayan GDP cycle between 1998 and 2022. On the basis of the estimated linear ARDL models that showed negative but weak relationships between the uncertainty indices and the GDP cycle, we test for the existence of structural breaks in these relationships. Although we find a significant break in the year 2003 for both indices and another in 2019 for one of them,

the Wald tests performed on the non-linear models only confirm the structural break in the early 2000s in the model with the index based on export market expectations. In this non-linear model, we find that the negative influence of uncertainty fades after 2003, probably associated with institutional changes that took place in the Uruguayan economy. The evidence of a differential influence before and after this date remains, even when controlling for the variability of non-tradable domestic prices. Two implications arise from these results. First, the evidence of relevant changes that turned the Uruguayan economy less vulnerable from 2003 ahead. Secondly, the importance of the expectation about the future of the export market on the macroeconomic cycle in a small and open economy such as the Uruguayan.

[7603] *Nonstationary Frequency Analysis of Extreme Rainfall in the Taihu Lake Basin, China*

Yuting Jin (Tongji University), Shuguang Liu (Tongji University, Key Laboratory of Yangtze River Water Environment), Zhengzheng Zhou (Tongji University), Qi Zhuang (Tongji University) and Guihui Zhong (Tongji University).

With global warming and rapid urbanization, extreme hydrometeorological events such as extreme rainfall/flood occur more frequently with increasing intensity and severe damage in urban areas. It results in the question about the update of the current design standard for hydraulic infrastructure to protect human life and properties. To this end, the nonstationarity-based frequency analysis of hydrological time series is of vital importance. In this study, taking Taihu Lake basin, which has experienced rapid urbanization in recent years, as an example, we examine the nonstationary in extreme rainfall time series and then propose a nonstationary-based frequency analysis. Using rain-gauge rainfall from 1961 to 2019 and IMERG satellite precipitation from 2000 to 2020, the magnitude, intensity, and duration of extreme rainfall are analyzed based on extreme rainfall indicators: the number of heavy rainfall days (R10mm), very wet days (R95p), and the maximum 1-day rainfall amount (Rx1d). In each of the 8 sub-regions in the basin, the Mann-Kendall (MK) test and the Pettitt test are used to identify the trend changes and mutations of rainfall series, and autocorrelation function (ACF) is used to analyze rainfall autocorrelation features. Based on the stochastic storm transposition (SST) method, a regional rainfall frequency analysis method based on the combination of regional probability resampling and rainfall spatial transformation, taking into account non-stationary variations, the intensity-duration-frequency curves (IDFs) of each water conservancy zone are obtained. The results show that the vast majority of rainfall series in the hydrological sub-regions in the basin show non-stationary variation and have passed the significance test. The frequency and intensity of extreme rainfall events have increased to different degrees in each hydrological sub-region. The nonstationary changes in extreme rainfall time series have a close link to regional urbanization development. The comparison of IDF between the conventional frequency analysis method based on stationary assumption and the SST-based method demonstrates significant differences. The conventional approach will lead to an underestimation of IDFs, thus increasing uncertainty in storm-derived flood estimations. The above output provides an important reference for understanding the nonstationary changes of extreme rainfall in the Taihu Lake basin and also provides scientific guidance for flood control planning through the nonstationary-based frequency analysis using remote sensing products in other basins that have similar hydrometeorological characteristics under the changing environment.

[7655] *EXAMINING THE DYNAMIC CONNECTEDNESS BETWEEN CRUDE OIL PRICE SHOCKS AND US SECTOR INDICES*

M. Caridad Sevillano (Universidad de Castilla-La Mancha), Francisco Jareño (Universidad de Castilla-La Mancha), Raquel López (Universidad de Castilla-La Mancha) and Carlos Esparcia (Universidad de Castilla-La Mancha).

This paper analyses the dynamic connectedness between crude oil price shocks - distinguishing demand, supply and risk shocks - and sector indices of the US equity market from 11 October 2001 to 14 January 2022, studying the impact of the two recent major crises: the 2008 global financial crisis and the COVID-19 pandemic crisis. Regarding the methodology, this paper is a combination of three techniques: decomposition of crude oil price shocks from Ready (2018), application of the TVP-VAR model proposed by Antonakakis et al. (2020) and time series decomposition through the wavelet approach. The results not only demonstrate the high connectedness between variables and how this varies over time, but also identify the roles of net receivers/contributors of shocks to the system. On the one hand, we find that all sector indices (except Communication Services, Public Sector and Real Estate) are net contributors. On the other hand, while supply and demand shocks are net receivers, risk shocks are net contributors to the system. Implications for investors and policy makers have been identified.

[7697] *This is a test. Please , remove*

Ignacio Rojas (University of Granada), Olga Valenzuela (University of Granada) and Ita Itise (University of Granada).
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[7770] *Times Series Regression Modelling: replication, estimation and aggregation through maximum entropy*

Jorge Duarte (University Púnguè, Bairro Heróis Moçambicanos, Chimoio, Manica, Mozambique), Maria Costa (CIDMA, Department of Mathematics, University of Aveiro, 3810-193 Aveiro, Portugal) and Pedro Macedo (CIDMA, Department of Mathematics, University of Aveiro, 3810-193 Aveiro, Portugal).

In today's world of large volumes of data, where the usual statistical estimation methods are commonly inefficient or, more often, impossible to use, aggregation methodologies emerge as a solution for statistical inference. This work proposes a novel procedure for time series regression modelling, where maximum entropy and information theory play a central role in the replication of time series, estimation of parameters and aggregation of estimates. The preliminary results reveal that this three-stage maximum entropy approach is a promising procedure in big data contexts.

[7804] *Dynamic Modeling and Forecasting: A Robust Approach based on the Rules Governing the Dynamic Behavior*

Muhammad Ashfaq Ahmed (Federal Board of Revenue) and Nasreen Nawaz (Michigan State University).

A robust model based on the rules governing the dynamic behavior has been proposed for modeling and forecasting of a non-cyclic response generated by a covariance stationary AR(p) process. The model is based on the most common approach of describing the dynamics of reaction processes in control engineering by a first order with transport lag model. The true dynamics of nearly all reaction processes is unknown just like true time series models in practice. The dynamics of all s-shaped industrial processes can be well approximated by a first-order plus time delay model. As all non-cyclic AR(p) processes are s-shaped responses if plotted after removing the white noise term, by translating the first-order with dead time model into an econometrics/statistics model, all AR(p) processes in non-cyclic range can be well approximated by that model.

[7827] *GDP, employment, and wages in Colombia. The challenge of creating more and better jobs*

Pablo Adrian Garlati-Bertoldi (Pontificia Universidad Javeriana).

The empirical evidence indicates that in Colombia, economic growth is not accompanied by an equal or greater amount of employment, hours worked, and/or labor income. For example, from the second quarter of 2007 to the fourth quarter of 2019, GDP grew at an average quarterly rate of around 0.9%, while employment, hours worked, and labor income grew at an average of 0.5%, 0.4%, and 0.1%, respectively. The preliminary results of this study indicate that GDP does not Granger-cause employment, but it does Granger-cause labor income. In addition, employment does Granger-cause GDP and labor income, while labor income does not Granger cause either GDP or employment. These findings hold and become even more statistically significant when employment is substituted with hours worked. These results suggest that public policies should focus on improving the functioning of the labor market to achieve greater economic growth. To the best of the author's knowledge, this is the first study to analyze these variables in Colombia. Future studies could focus on the disaggregated performance of formal versus informal employment in conjunction with economic growth. Such studies could be applied to Colombia and other developing countries that suffer from high and persistent levels of informality.

[7920] *Categorical Data Encoding Techniques for Recursive Multi-Step Prediction of Vessel Trajectory*

Robertas Jurkus (Vilnius University), Julius Venskus (Vilnius University) and Povilas Treigys (Vilnius University).

In recent years, there has been growing interest in using deep learning techniques to improve vessel trajectory prediction accuracy by leveraging AIS satellite data. This paper will explore the potential benefits of using deep learning algorithms and categorical vessel-type data in vessel trajectory prediction for maritime safety. The experiments use different categorical encoding techniques, such as Ordinal, One-hot, and multidimensional Embedding for accuracy comparison when no categorical vessel variable is used. All techniques employ LSTM recursive multi-step forecasting.

[7952] *Impact of oil and energy prices on inflation and inflation expectations: comparison of COVID-19 and war periods*

Agata Kliber (Poznan University of Economics and Business) and Magdalena Szyszko (WSB University in Poznan).

The article determines the impact of oil, fuels and energy prices on the inflation expectations of households. We analyse data from COVID-19 to December 2022, covering two periods of uncertainty - the pandemic and the Russian invasion of Ukraine. The latter contributed to the outbreak of political conflict in Europe. In particular, European Union decided to impose sanctions on Russia, which included, inter alia, the ban on oil and gas imports. Of the sanctioned products, the latter is most critical due to the heavy reliance of the EU member states on the oil and gas import from Russia. The strength of that dependence varies across Europe. Therefore, we compare the countries heavily dependent on Russian oil (Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania) and the relatively independent countries (Denmark, Sweden). All economies implement inflation-targeting, and their monetary policy is independent of the European Central Bank.

Many researchers have investigated the relationships between oil price shocks and inflation. For instance, Salisu, Isah, Oyewole, and Akanni (2017) examined the role of asymmetries in the oil price-inflation nexus for selected net oil exporting and net oil importing countries. The period covered in the study encompassed 2000-2014. The authors showed a significant long-run positive relationship between oil price shocks and inflation. Moreover, they confirmed that price asymmetries matter more when dealing with oil-exporting nations. Sek, Teo and Wong (2015), using the autoregressive distributed lag (ARDL) approach, showed that oil price change directly affected domestic inflation in countries with low oil dependency. On the contrary, its impact was indirect in the high oil-dependency economies. Kpodar and Liu (2022) showed that the response of inflation to gasoline prices is smaller but more persistent in developing economies than in advanced economies. When the purchasing power of all households declines as fuel prices increase, the impact is progressive.

Fewer researchers examined the impact of oil prices on inflation expectations formulated by consumers. Cabral, Ribeiro and Nicolau (2022) investigated the relationship between changes in euro area short-term and long-term market-based inflation expectations from January 2005 to September 2018. The authors demonstrated that changes in short-term inflation expectations tend to respond to the movements of oil prices over time, while changes in longer-term ones started responding to crude dynamics after mid-2008. Bec and de Guy (2016) investigated the associations between oil forecast accuracy and inflation expectations errors for the US, The UK and France. The scholars confirmed the relationship and suggested that when the oil price volatility is high, inflation forecast errors are typically multiplied by around 2. This study confirms the relevancy of the discussion on inflation forecast and oil prices in a turbulent economic environment.

Our paper is inspired by Kilian and Zhou (2022), who analysed the impact of oil and gasoline prices on inflation and inflation expectations in the USA. The authors used the Bayesian structural VAR approach. They documented no evidence that gasoline price shocks have increased long-run household inflation expectations. They also denied that the inflationary effect of gasoline price shocks was persistent. The short-run impact on headline inflation was sizable but accounted for only a tiny fraction of overall inflation.

Our paper extends the Kilian and Zhou (2022) work. We broaden the analysis to cover the European economies that, up to date, retained their currencies. Moreover, all of them implement an inflation targetting framework. Among them, we distinguish groups strongly or weakly dependent on the oil import from Russia. The results for Sweden and Denmark should be similar to the ones obtained for the US. At the same time, the reaction of inflation expectations among countries highly dependent on oil should be different.

As an opening step, we run the Granger causality test for each country to verify whether there may be causality from oil, fuels and energy prices to the inflation expectations and inflation itself. Next, following Kilian and Zhou (2022), we estimate a Bayesian structural VAR to investigate the possible impact of oil, fuels and energy shocks on inflation expectations and inflation. In the model, we include exchange rates, industrial production index, consumer price index and interest rate as control variables.

References: Bec, F., de Guy, A., 2016. How do oil price forecast errors impact inflation forecast errors? An empirical analysis from US, French and UK inflation forecast. Economic Modelling 53,75-88. Cabral, I.d. C., Ribeiro, P.P., Nicolau, J., 2022. Changes in inflation compensation and oil prices: short-term and long-term dynamics. Empirical Economics , 1–2; Kilian, L., Zhou, X., 2022. The impact of rising oil prices on us inflation and inflation expectations in 2020–23. Energy Economics 113, 106228; Kpodar, K., Liu, B., 2022. The distributional implications of the impact of fuel price increases on inflation. Energy Economics 108, 1; Salisu, A.A., Isah, K.O., Oyewole, O.J., Akanni, L.O., 2017. Modelling oil price-inflation nexus: The role of asymmetries. Energy 125, 97–106; Sek, S.K., Teo, X.Q., Wong, Y.N., 2015. A comparative study on the effects of oil price changes on inflation. Procedia Economics and Finance 26,630–636.

[7966] *Time series forecasting by combining LSTM RNN and ARIMA*

Akvilina Akstinait (Nova Information Management School (NOVA IMS), Universidade Nova de Lisboa, 1070-312, Lisboa, Portugal) and Roberto Henriques (Nova Information Management School (NOVA IMS), Universidade Nova de Lisboa, 1070-312, Lisboa, Portugal).

This study aims to analyse the performance of the ensemble model – the combi-nation of the Long Short-Term Memory Recurring Neural Network model with the ARIMA model. We developed these models separately to perform the best on their own in predicting prices 1, 7, and 14 observations while considering the last 30, 60 and 90 observations and checking if the combination of them outperforms the stand-alone models. We evaluated the models based on RMSE and their ability to predict the turning points. Models were developed and tested on two securities – the index S&P 500 and the cryptocurrency Bitcoin (BTC). The combined methods demonstrated strong performance on the BTC data set and gave at least 90% turning point prediction accuracy when predicting the price for one observation ahead. For the S&P 500 data set, the performance of the stacked model was poor – it outperformed the stand-alone models only in one test out of eighteen – while predicting prices one observation ahead, look-ing back at the past 30 observations.

[7970] *Importance of the agricultural sector in the Ecuadorian economy*

Victor Xavier Quinde Rosales (Universidad Agraria del Ecuador), Rina Mercedes Bucaram Leverone (Universidad Agraria del Ecuador) and Luis Enrique Mejia Cervantes (Universidad Agraria del Ecuador).

In recent years, agriculture has become the backbone of the Ecuadorian economy, playing a crucial role in the country's economic growth. Accordingly, the objective of this study is to examine the impact of agricultural exports on Ecuador's economic growth during the period 1990-2021. The methodology used is based on an inductive reasoning under an empiricalanalytical approach, a Vector Autoregressive (VAR) model was generated in order to analyze the existence of a causal relationship between the variables analyzed. The results showed that there is no causal relationship between the variables under study, indicating that agricultural exports do not cause the country's economic growth and vice versa

[7975] *Assessment of wave energy availability in the Romanian nearshore of the Black Sea*

Sorin Ciortan ("Dunarea de Jos" University of Galati).

One of the most targeted renewable energies' areas is the offshore space. Here, there is a large availability of both wave and wind energy. Comparing with the onshore spaces, where the placement of solar and wind farms has several restrictions, mainly linked to the agriculture areas, dust, noise etc., in the offshore the environmental conditions for the wave and wind energy farms are more relaxed. However, there are also some drawbacks, like the harvesting devices' design and maintenance or the transport of the obtained electricity to the shore. Even if the latest developments in technologies allowed an expansion of energy farms also in deeper waters, the nearshore area is the most promising one [1]. Taking into account that climate changes lead to large variations in wind speed and wave parameters, in order to obtain the best efficiency, an appropriate evaluation of the future evolution of these must be performed. Also, the performance of the devices used to harvest the renewable energy must be correlated with the placement location's parameters [2]. In this work, an evaluation of wave energy in the Romanian offshore area in the Black Sea is presented. The proposed methodology is based on modelling with Artificial Neural Networks (ANN) and allows, starting from historical and predicted data, to identify the areas where the waves offer the best opportunity for energy extraction, meaning both higher significant height and lowest average value variation during a specified interval of time. Other objective of the present work is to identify which type of wave energy converter is most suitable for the identified locations. The ANNs are parallel computing systems, working in a similar way with the biological brain. These are capable

to "learn" from presented input-output correlated data, modelling this way a phenomenon without involving mathematical equations. Taking into account that in the wave energy domain, the computing formulas usually contains several correlation coefficients [3], the obtained precision is directly liked to the correctness of these. From this point of view, the ANNs, working only with raw data, can provide more precise results [4]. However, there is a drawback in modelling with ANNs: for each dataset there is a particular ANN, with specific properties, offering the best results. As consequence, in order to build the best model an optimization based on genetic algorithms should be performed. In order to perform an investigation on the wave energy availability, an area with water depth less than 50 m was identified in Romanian nearshore [5]. Using as input data the GPS coordinates of area borders and the data regarding the future waves computed with a wave model forced by the Euro-CORDEX wind fields simulated under Representative Concentration Pathway emission scenario 4.5 (RCP4.5) [6], an ANN model was built. After performing the training and validation of the model, the points with the highest wave energy potential were identified. Also, the identification of the most influencing input was possible. Based on ANN model predictions, the points where the waves' properties allow an efficient energy extraction were identified. As choosing criteria were considered the wave significant height value and variation during the selected period of time. Also, based on wave energy converters' technical specifications corroborated with wave properties, the best device-extraction point match was established

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[8009] *Trading on short-term path forecasts of intraday electricity prices*

Tomasz Serafin (Wrocław University of Science and Technology), Grzegorz Marcjasz (Wrocław University of Science and Technology) and Rafał Weron (Wrocław University of Science and Technology).

We introduce a profitable trading strategy that can support decision-making in continuous intraday markets for electricity. It utilizes a novel forecasting framework, which generates prediction bands from a pool of path forecasts or approximates them using probabilistic price forecasts. The prediction bands then define a time-dependent price level that, when exceeded, indicates a good trading opportunity. Results for the German intraday market show that, in terms of the energy score, our path forecasts beat two well performing literature benchmarks by over 30%. Moreover, the forecasts provide empirical evidence that the increased computational burden induced by generating realistic price paths is offset by higher trading profits. Still, the proposed approximate and bootstrap-based methods offer a reasonable trade-off — they do not require generating path forecasts and yield only slightly lower profits.

[8056] *Analysis of GNSS time series recorded on South Shetland Island and Antarctic Peninsula during the geodynamic activity in 2019 of the underwater volcano ORCA (Brandfield Sea Rift, Antarctica).*

Belén Rosado (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Paola Barba Ceballos (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Javier Ramirez (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Enrique Carmona (Instituto Andaluz de Geofísica. Universidad de Granada.), Rosa Martín León (Instituto Andaluz de Geofísica. Universidad de Granada.), Vanessa Jiménez Morales (Departamento de física teórica y del cosmos. Universidad de Granada), Jorge Gárate (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz), Amos de Gil (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz) and Manuel Berrocoso (Laboratorio de astronomía, geodesia y cartografía. Universidad de Cádiz).

The region defined by the South Shetland Islands, Bransfield Sea and Antarctic Peninsula has complex geodynamic activity resulting from the active subduction process of the Phoenix Plate under the Antarctic Plate. This subduction produces a rift of expansion along the Bransfield Sea basin between the South Shetland Islands and the Antarctic Peninsula; There is also a chain of submarine volcanoes (Orca, Three Sisters and Building A) and emerged (Deception and Pinguin). In 2020 there is intense seismic activity around the Orca volcano with earthquakes of up to 6.9 Mw. This paper presents the models of stress and deformation that this seismic activity produces in the region. The geodetic time series of the GNSS stations located in the region are analyzed: UYBA in the Uruguayan Base Artigas (I. Rey Jorge); BEJ1 at the Spanish Base Juan Carlos I on Livingston Island; BEGC at the Spanish Base Gabriel de Castilla on Deception Island and OHI3 at the Chilean base O'Higgins on the Antarctic Peninsula. The study will be complemented with data from other stations in the area included in the GNSS MAGNET database (University of Nevada, USA).

[8080] *A New Asymmetric GARCH Model: Testing, Estimation and an Application to Falling and Rising Markets*

Abdulnasser Hatemi-J (UAE University).

Since the seminal work by Engle (1982) [1], the autoregressive conditional heteroscedasticity (ARCH) model has been an important tool for estimating the time-varying volatility as a measure of risk. Numerous extensions of this model have been presented in the literature. The current paper offers an alternative approach for dealing with asymmetry in the underlying volatility model. Unlike previous papers dealing with asymmetry, this paper suggests to explicitly separate the positive price shocks from the negative ones in the ARCH modeling approach. A test statistic is suggested for testing the null hypothesis of no asymmetric ARCH effects. In case the null hypothesis is rejected, the model can be estimated by using the maximum likelihood method. The suggested asymmetric volatility approach is applied to modeling separately the potential time-varying volatility in markets that are rising or falling by using the changes in the world market stock price index. The results have important repercussions for the investor dependent on having a long or a short position in the underlying investment.

[8107] *Bayesian Robust Multivariate Time Series Analysis in Nonlinear Regression Models with Vector Autoregressive and t-distributed Errors*

Alexander Dorndorf (Institute of Geo-Engineering, TU Clausthal), Prof. Boris Kargoll (Institut f ̈ur Geoinformation und Vermessung Dessau, Hochschule Anhalt Dessau-Roßla), Prof. Jens-Anfré Paffenholz (Institute of Geo-Engineering, TU Clausthal) and Pd Dr. Hamza Alkhatib (Geodetic Institute, Leibniz University Hannover).

Time series analysis has become an important tool in many fields such as geodetic measurement processes, finance, economics, and engineering, where the observed data are collected in temporal order. The geodetic measurement process relies on sensors that have high spatial and temporal resolutions, which leads to a large amount of data with outliers. These observations violate the assumption of uncorrelated random deviations between the observation times. Therefore, a Bayesian multivariate time series model with a vector autoregressive (VAR) process is developed in this paper. The model is suitable for the analysis of these observed data and includes prior knowledge about various model parameters.

The proposed model uses a multivariate non-linear regression model with a stationary VAR process and a multivariate t-distribution for the white noise \cite{lange-etal:1989}. The posterior distribution of the unknown parameters is obtained using Markov Chain Monte Carlo (MCMC) techniques, specifically a Metropolis-within-Gibbs algorithm. In addition to the unknown functional parameters, the unknown VAR coefficients, the unknown scaling parameters, and the unknown degree of freedom of the multivariate t-distribution are also estimated in this Bayesian model.

Prior knowledge about the unknown parameters is incorporated into the proposed model. Specifically, for the VAR coefficients, a prior distribution is assumed to be Gaussian, and the prior mean and variance are estimated from previous data or expert knowledge. The degree of freedom parameter of the t-distribution is assigned an informative prior based on previous studies, and the scaling parameters are assigned an inverse gamma prior distribution.

The paper first discusses the mathematical foundations of classical and Bayesian time series analysis and highlights the differences between them. In classical time series analysis (\cite{alkhatib-etal:2018} and \cite{kargoll-etal:2020}), the VAR coefficients are regarded as fixed, whereas in Bayesian time series analysis, they are considered as random variables that require a prior density for the parameters to be estimated. The proposed Bayesian VAR model in this paper is an extension of the algorithm proposed in \cite{dorndorf-etal:2021} to deal with a VAR process more generally. The classical time series model is implemented using the Generalized Expectation Maximization (GEM) algorithm \cite{kargoll-etal:2020}.

The proposed model is illustrated using simulated data and compared with the classical time series analysis model (\cite{kargoll-etal:2020}). The results show that the proposed Bayesian model outperforms the classical model in terms of accuracy and robustness. The proposed model is also applied to a real-world data set to demonstrate its practical usefulness.

In conclusion, the proposed Bayesian multivariate time series model with a VAR process and t-distributed errors is a valuable tool for the analysis of geodetic measurement data with high spatial and temporal resolutions. The inclusion of prior knowledge about various model parameters improves the accuracy and robustness of the model. The proposed model outperforms classical time series models, such as the GEM algorithm, in terms of accuracy and robustness. Moreover, the Bayesian approach enables the direct estimation of the variance-covariance matrix of all parameters,

whereas the estimation of such a matrix in GEM is very computationally extensive and requires a bootstrapping algorithm. The proposed model is expected to be useful in various fields such as finance, economics, and engineering, where high-resolution time series data are collected.

[8110] *Stock, Exchange and Commodity Markets Linkages: Implication for Risk Diversification and Portfolio Management*

Jorge Muñoz Mendoza (University of Concepcion / University of Barcelona), Carmen Veloso Ramos (University of Concepcion), Carlos Delgado Fuentealba (University of Concepcion), Edinson Cornejo Saavedra (University of Bio-Bio), Sandra Sepúlveda Yelpo (University of Concepcion) and Diego Gómez Melo (University of Concepcion).

We analyze the connectedness for a system composed of 116 financial markets for the period from January 3, 2011 to August 12, 2022. Stock, foreign exchange and commodity markets are included in the sample. Using a two-stage approach based on Principal Component Analysis to remove common global factors affecting financial market returns, we employ a LASSO-VAR model to estimate the global network of financial markets. Our results reveal financial markets are closely linked. Common global factors intensify spillovers between financial markets. After being removed, financial markets transmit significant idiosyncratic shocks that are not explained by system variations. The stock markets of Slovakia, Bosnia and Herzegovina, Tunisia, Morocco, Iceland, Luxembourg, Slovenia, Mauritius and Malaysia; the foreign exchange markets of Vietnam, Indonesia, and China; and the rice, nickel and palladium markets are less connected to the network and offer the best diversification opportunities. Of all the idiosyncratically relevant markets within the network, the foreign exchange markets are the ones located in the most central regions and transmit the most important shocks to the system. These findings are relevant for investment decisions, risk management and for financial regulators.

[8115] *Connectedness in the Global Banking Market Network: Implications for Risk Management and Financial Policy*

Jorge Muñoz Mendoza (University of Concepcion), Carmen Veloso Ramos (University of Concepcion), Carlos Delgado Fuentealba (University of Concepcion), Iván Araya Gómez (University of Concepcion), Sandra Sepúlveda Yelpo (University of Concepcion) and Edinson Cornejo Saavedra (University of Bio-Bio).

We analyze the connections between 195 banks from 41 countries for the period between January 03, 2005, and March 26, 2021. Using a two-step approach, first we remove the common global factors from banking stock returns, and next we use the LASSO-VAR model to estimate the network for banking stock markets. Our results reveal that banking stock markets are closely integrated around the world, especially between the market geographically closer. The non-idiosyncratic components of banking stock returns, related to common global factors that affect them, act as a vehicle that amplifies shocks and biases upward the incidence of markets and banks in the worldwide network. Bermuda, Sri Lanka, South Korea, Russia, Ireland, Thailand, Argentina, Norway, Malaysia, Denmark, Belgium, India, and Hong Kong are the markets that offer significant advantages to diversifying risk as they are located in the outer part of the banking network and receive the lowest idiosyncratic spillovers from other markets. However, the banking markets of Pakistan, China, Greece, Jamaica, France, Sweden, Brazil, Finland, Taiwan, Mexico, Italy, Canada and Australia transmit the largest idiosyncratic spillovers to other markets, and they have a greater incidence on financial contagion within the banking markets network. At the bank level, we also identify the less vulnerable and more essential banks in the network. These results have important implications for investment decision-making and policymakers.

[8133] *Statistical haplotypes based on Functional Sequence Data Analysis for Genome-Wide Association Studies*

Pei-Yun Sun (The University of Melbourne) and Guoqi Qian (The University of Melbourne).

Functional data analysis has demonstrated significant success in time series analysis. In recent biomedical research, it has also been used to analyze sequence variations in genome-wide association studies (GWAS). The observations of genetic variants, called single nucleotide polymorphisms (SNPs), of an individual are distributed over the loci of a DNA sequence. Thus, it can be regarded as a realization of a stochastic process, which is no different from a time series. However, SNPs are usually coded as the number of minor alleles, which are categorical. The usual least square smoothing in FDA only works well when the data is continuous and normally distributed. The normality assumption will be violated for

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categorical SNP data. In this work, we propose a two-step method for smoothing categorical SNPs using a novel method and constructing haplotypes having strong associations with the disease using functional generalized linear models. We show its effectiveness through a real-world PennCATH dataset.

[8195] *Sustainable Investments and Investor-Surplus During Crisis*

Xiang Lin (Södertörn University) and Ranjula Bali Swain (Stockholm School of Economics and Södertörn University).

We investigate the investor-surplus of sustainable investments, which is defined as a difference between the actual and willingly accepted losses, before and during COVID-19 pandemic. The empirical analysis is based on 19 Morgan Stanley Capital International (MSCI) country Environmental, Social, and Governance (ESG) Leaders indices, which screen out assets with the lower-than-average ESG scores, during the period of 2017 to 2021. Based on the Capital Asset Pricing Model (CAPM), we employ Markov Autoregressive Regime Switching approach to identify investor-surpluses across alternative regimes. Our empirical evidence shows that positive investor-surpluses of sustainable investments exist for ESG-motivated investors, even during the COVID-19 crisis.

[8226] *Enhancement of consumption forecasting by customers' behavioral predictability segregation*

Maria Koshkareva (ITMO University) and Anton Kovantsev (ITMO University).

The easiest approach to consumer activity forecasting involves using the whole available and applicable population of financial actors which the certain data set contains. The drawback of this simple technique is twofold: the set could be too big, and it could contain clients of very different peculiarities, which means that actors whose previous behavior is helpful for the forecast and whose one is not are mixed, and while the first perform good quality prediction the second spoil it by adding noise. Hence, if we could choose the agents of good predictability and put aside the others "as a shepherd divideth his sheep from the goats" (Matthew 25:32) we would solve both problems: less data volume and less noise; the principle is like ancient "divide et impera". Scaling will help to restore true values for the whole population. A single actor predictability, which we measure for our purpose, always changes over time, especially if some critical events occur. This is why we apply the incremental tracing of behavioral predictability dynamic. This dynamic itself can also clarify issues of customer separation in both sustained and critical periods. So, in our research we developed the method of financial actors separation by predictability and its dynamic for and demonstrated its benefits and drawbacks in forecast improvement.

[8268] *NOWCASTING REGIONAL ECONOMIC ACTIVITY IN ITALY DURING THE PANDEMICS*

Francesco Montaruli (Bank of Italy) and Valter Di Giacinto (Bank of Italy).

The aim of this paper is to describe the new ITER models adopted during and after the COVID pandemia, in order to obtain a nowcasting of the economic activity in the 4 Italian Macroareas. In practice the original models have been complemented with bridge models and other econometric strategies to reduce the time lag of estimation, with respect to the official GDP national publication. The results have reduced the lag from 3 months to only one month with respect to the official national GDP release. Moreover, other forecast strategies have been applied due to the increased volatility and a shrinkage method has increased the consistency. The research project is currently studying vector autoregression and Bayesian instruments to complement forecasting out of sample.

1. Introduction The ITER Index has been obtained applying temporal disaggregation techniques of annual GDP. To do so a set of indicators highly correlated to the GDP and of a higher frequency (quarterly or monthly) have been employed as exogenous variables. The original project released GDP estimations after three months of the nearest public national GDP. This time lag was due to an ordinary difficulty to obtain the necessary exogenous variable well in advance (see table 1). From 2020 onwards, the pandemic has imposed a need to obtain fresh estimations for the GDP also at regional level. That need has imposed a deep effort to update well in advance the estimation; the objective being to nowcast the regional GDP if possible in line with the preliminary release of the national GDP (id est only 30 days later the flash national GDP preliminary estimate). In order to calculate the regional GDP nowcast coherently with the national preliminary GDP new forecast technique have been applied to expand the exogenous variable series and reduce the time lag for the ITER publication. This paper describes the new ITER models and strategy adopted during and after the COVID pandemia, in order to obtain a nowcasting of the economic activity in the 4 Italian Macroareas. In practice, the original

models have been complemented with bridge models and other econometric strategies to reduce the time lag of estimation, with respect to the official GDP national publication. The exogenous indicators have been projected forward by using proxy variables of higher frequency of different kinds. Those proxies are used in auxiliary regressions and can be available few weeks (electricity consumption, unemployment benefits) or one month after the national GDP release. 2. Models to predict the covariate variables The empirical nowcasting strategy is as follow. Let us suppose that the preliminary estimation is at time T, a related exogenous variable (indicator or covariate) available for T-1 is forecast to T using an auxiliary econometric model, which contains other variables correlated to the main indicator in the original ITER model. Hence, in any regional macroarea of Italy ad hoc auxiliary regressions have been identified. At the same time, but preliminarily to the regional nowcasting exercise, a consistency exercise to calibrate the auxiliary models to the Italian official forecast of the main standard indicator of the ITER regression models is conducted. This is to ensure that overall the auxiliary models will be consistent to the Italian GDP previously released at aggregate level in the same vain to the balancing exercise for ITER.   Here is a brief description of the auxiliary models: Unemployment. The models to forecast unemployment in each macro area are obtained using a variety of new high frequency variables per area, among which are regional business confidence indicators, external demand Italian ECB index, various adjustments have been adopted to those data. Export. Export forecast are usually obtained with multiple dynamic regression models, using as proxies various indexes of business climate and external demand and exchange rate indicators. The industrial production index. In this case the Index is forecast by using monthly regressions in which the exogenous variables employed are related to the opinions on the future level of production, as requested in the survey to the entrepreneurs. Moreover, a proxy related to electricity consumption has been proved very significant, as expected. Real estate business. To forecast the real estate business dynamic a series of different indicators has been used including on line changes from the internet announcements. 3. Main results for 2020 to be completed for the next years… Overall, the models show a good adaptation to the data, notwithstanding the higher volatility of the pandemic time and related uncertainty of the short term business cycle. In Fig. 1 for every macro area a comparison in 2020 is reported. The regional GDP nowcast obtained thanks to those auxiliary models and the second estimation obtained later with the ex post values for the ordinary covariates are very close, after balancing for the Italian second GDP release.

[8310] *Adaptive bandwidth based on maximum variance of information potential for Gaussian kernel adaptive filters*

Juan David Hernández-Sánchez (Universidad Tecnológica de Pereira), Álvaro Ángel Orozco Gutiérrez (Universidad Tecnológica de Pereira) and David Augusto Cárdenas-Peña (Universidad Tecnológica de Pereira).

Adaptive filters are a class of learning algorithms devoted to online signal processing. Their kernel version, Kernel Adaptive Filter (KAF), develops the traditional linear filters in a reproduced kernel Hilbert apace, making them nonlinear filters in the input space. Among the various feasible kernel functions, the universal approximation property of Gaussian kernels makes them the standard choice. However, the election of an optimal kernel bandwidth remains an open research line as there lacks a well-established automatic tuning procedure. Despite achieving acceptable performance results, the presence of nonlinear chaotic signals, fast dynamics to follow, and non-stationarities hamper the performance of fixed bandwidths. Then, adaptive approaches become more suitable. This work introduces an online update rule for optimizing the kernel bandwidth by maximizing the variance of the information potential. The information-theoretic learning criterion yield an epoch-wise optimal bandwidth that feeds the quantized kernel least mean square (QKLMS) filter. The experiments contrast the proposed approach against the conventional QKLMS and a well-known adaptive bandwidth algorithm in predicting time series from nonlinear systems, chaotic attractors, and real data. Results evidence performance improvements in prediction accuracy, convergence rate, and compact modeling.

[8322] *On the statistical characteristics of dry and rainfall events in northern Tunisia*

Majid Mathlouthi (LRSTE at INAT, Tunisia) and Fethi Lebdi (INAT, Tunisia).

A statistical analysis of dry event derived from a series of daily rainfall observations, according to a predetermined threshold value, was carried out. The accent has been put on the modeling and computation. The approach has been illustrated on a case study of Ghezala Dam northern Tunisia. The average rainfall is 680 mm. The rainy season extends from September to April where the observed daily rainfall varies between 0.1 and 103.1 mm. In this methodology, the dry events are constituted of a series of dry days framed by the rainfall events. Rainfall events are defined themselves in the form an uninterrupted series of rainfall days understanding at least a day having received a precipitation superior to a threshold of 3.6 mm (average daily evapotranspiration). The rainfall events are defined by depth and duration, which are

found to be correlated. An analysis of the depth per event conditioned on the event duration has been undertaken. The negative binomial distribution appears the best overall fit for the depth per event lasting one day. The duration of the rainfall event follows a geometric distribution while that the dry event follows the negative binomial distribution. The length of the climatically cycle adjusts to the Incomplete Gamma. A simulation procedure stage by stage by Monte Carlo method has been executed to generate synthetic sequences of rainfall events and dry event with correspondent lengths of rainy season.

[8352] *Time series analysis in hydrogeological conceptual model upgrading*

Paola Gattinoni (Politecnico di Milano).

The modelling of hydrogeological processes often involves a quantitative de-scription of complex systems in which limited data-set are available, bringing about the formulation of conceptual models able to describe them in a sim-plified framework. In order to evaluate the reliability of these conceptual models a statistical description of the elements composing the system can be useful, especially with reference to their mutual interactions. The study shows, through some applicative examples in the hydrogeological field, that the statistics analysis of characterizing parameters and cause–effect relations arising from time series monitoring data can give useful information about the system dynamic, thus contributing to update the conceptual model and therefore improving the results of following numerical modelling. Indeed, this dynamic description of the system, with the introduction of verification and validation processes of the conceptual model, allows to correct possible errors dues to lack in data or phenomenon complexity, leading to face many hydrogeological issues, such as the identification of the most productive aq-uifer or the one having the highest vulnerability to pollution, as well as zones interested by groundwater flow that can trigger slope instability.

[8354] *Prediction of birch and ragweed pollination season in northeastern part of Croatia in a changing climate*

Edita Stefanic (Faculty of Agrobiotechnical Sciences in Osijek), Alka Turalija (Faculty of Agrobiotechnical Sciences in Osijek) and Marin Lukacevic (Faculty of Agrobiotechnical Sciences in Osijek).

Pollen represent one of the most common triggers of seasonal respiratory allergies. Each pollen grain is a single cell produced by seed plants in the male cone of a conifer or other gymnosperm, or in the anthers of an angiosperm flower, with the purpose of transport male DNA to the female part of the flower. They are released by plants as part of their reproductive cycle, but depending on the time of the year, different pollen type will be present in the air. Pollen allergies are common in temperate climate zones with the seasonal pollen production. In temperate zone of northern hemisphere some of the common pollens with high allergenicity are those of birch -Betula sp., and ragweed - Ambrosia artemisiifolia L.. The most efficient way to manage a pollen allergy is to avoid triggers and take medications to prevent symptoms. To avoid trigger, the most important information for the allergic people are the beginning, peak and end of the pollen presence in the air. However, both the onset and the duration of pollen season are depended on meteorological variables. The aim of this study was to analyse how birch and ragweed pollen concentrations are influenced by meteorological elements in northeastern part of the Croatia. Data was ,obtained from eighteen years of aerobiology studies in the North-eastern part of the Republic of Croatia, in the city of Vinkovci (45017'28''N, 018048'04''E), located in the eastern part of the Slavonia region. The city lies in a flat landscape on Bosut river, at an elevation of 90 m above mean sea level. The whole region experiences a warm and moderate to dry lowland climate with average yearly temperature of 11.4 °C, and average yearly precipitation of 699 mm. The database for this study includes: two air pollutants birch (for the spring period) and ragweed (for the late summer period), and daily means of eight meteorological elements from the 2004 to 2022. Hirst-type of volumetric sampler (Burkard 7-day volumetric spore trap) was used to collect airborne pollen, and daily values were represented as number of pollen grains per cubic meter of air. Counts were performed on four continuous longitudinal lines along the microscopic slide. Meteorological elements used in this analysis were as follows: mean air temperature (Tmean, 0C), maximum air temperature (Tmax, 0C), minimum air temperature (Tmin, 0C), daily temperature range (DTR = Tmax – Tmin, 0C), relative humidity (RH, %), precipitation rate (P, mm), wind speed (WS, m/s), and global radiation (I, MJ/m2). Data were obtained from the State Hydrometeorological Institute, station Vinkovci. Factor analysis was applied on initial datasets consisting of ten correlated variables (8 meteorological variables and 2 aeroallergens characterizing weather and air quality of the actual days) in order to transform the original variables into fewer uncorrelated variables. To determine the number of retained factors, the Guttman criterion was used, which keeps factors with eigenvalues greater than 1. Then, in order to select the most appropriate factors, orthogonal varimax rotation was applied during which factors remain uncorrelated. Statistical

calculations were performed by using SPSS Statistical Software. Birch trees release their pollen early in the season, with the peaks between April and May. Ragweed pollen season begins in early August and peaks in mid-September and October.   After performing the factor analysis, 3 factors were retained according to the Guttmann criterion both for the birch (spring) and ragweed (late summer) pollination season. The 3 retained factors explain 76,2 % of the total variance for the birch pollination season. It can be seed that temperature parameters (Tmean, Tmin, Tmax, DTR), precipitation, humidity and radiation contribute significantly to the formation of birch pollen season. Ragweed pollen season account for 70,9% of the total variance of the eight variables. Warm temperature (Tmean, Tmax and DTR), reduced humidity and breezy conditions favors the presence of ragweed pollen in the air.

[8367] *Probabilistic Forecasting with Innovations: a deep-learning approach to nonparametric forecasting*

Lang Tong (Cornell University), Qing Zhao (Cornell University), Xinyi Wang (Cornell University) and Men-Jen Lee (Cornell University).

I. Background and Motivations

We consider the problem of nonparametric probabilistic forecasting in time series under unknown probability models. In particular, we are interested in obtaining a generative model of time series variables at a future time, conditioned on current and past observations.   Such a model can then be used to produce conditional statistics, including various types of point forecasts.

The specific application we have in mind is the probabilistic forecasting of wholesale market prices of electricity. The needs for such forecasts arise from the increasing stochastic nature of wholesale electricity market operations with large-scale penetrations of wind and solar generations. For a system operator, high-quality probabilistic price forecasts are crucial in managing risks in balancing demand and highly stochastic renewable supplies. Such forecasts can also be used as critical market signals that elicit resource participation during periods of severe scarcity. Such probabilistic forecasts also enable risk-based offer strategies for market participants in multiple energy and ancillary markets.

Unlike forecasting demands from physical processes, forecasting locational marginal prices is challenging because the wholesale market prices are derived from binding constraints in economic dispatch optimizations. No natural parametric model effectively captures the highly volatile dynamics of real-time prices. Typically, the state-of-the-art point forecasts of wholesale prices are an order of magnitude worse than demand forecasts, and few probabilistic forecasting techniques are available for real-time wholesale market price forecasting.

II. A Canonical Time-Series Representation via Innovations.

In 1958, Wiener and Kallianpur posted the problem of efficient representation of a time series as one of causal encoding and decoding of the time series. They conjectured that an arbitrary stationary process could be causally transformed to and causally recovered from the canonical independent and identically (and uniformly) distributed (IID) sequence. The causality of the transforms has the cogent interpretation that every sample of the transformed IID sequence, being statistically independent of all past observations, contains new information revealed by the most recent data sample. Such an IID sequence was later referred to as an innovations sequence by Masani. Through the lens of modern machine learning, what Wiener and Kallianpure considered is a causal autoencoder architecture for which the latent process is an IID innovations sequence.

The innovations representation of time series is powerful, universal, and entirely nonparametric; it is at the heart of Kalman-filtering-based forecasting. The innovations autoencoder disentangles without losing the temporal dependencies of the time series essential in forecasting. More significant, perhaps, is that any form of optimal forecasting based on past observations with arbitrary probabilistic dependencies is equivalent to finding the optimal decision based on the IID uniform innovations sequence.

Unfortunately, Wiener's innovations representation has two critical shortcomings that prevent its broad applications beyond the limited stationary Gaussian processes. One is that the innovations representation of Wiener may not exist for a considerably large class of time series models, including some of the typical finite-state Markov chains. Second, even when such a representation does exist, there is no known way to construct the causal encoder and decoder that extract the innovations representation.

III. Contributions: Nonparametric Probabilistic Forecasting via Innovations.

We develop a novel nonparametric forecasting approach based on the weak innovations representation originally proposed by Rosenblatt. In particular, Rosenblatt relaxes the requirement of perfect causal reproduction of the original

time series to the reproduction of a time series with the same probability distributions. It has been shown that Rosenblatt's innovations representation applies broadly to most time series models commonly encountered in practice.

The main contribution of this work is a generative adversary network to extract the weak innovations representation of the time series. Probabilistic time series forecasts are obtained using Monte Carlo techniques from the extracted weak innovations sequence via a Monte Carlo technique. We then apply the developed forecasting algorithm to the probabilistic forecasting of wholesale market prices using the actual data set from the New York Independent Systems Operator (ISO). Comparisons with state-of-the-art benchmarks are presented.

[8369] *Wind Energy Turbines Assessment Regarding to the Wind and Price Instability*

Doron Greenberg (Ariel University), Michael Byalsky (The Hebrew University of Jerusalem) and Asher Yahalom (Ariel University).

Wind Energy Turbines Assessment Regarding to the Wind and Price Instability

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Abstract The well-known limitedness of the nonrenewable local energy resources in Israel, even nowadays in the background of the later gas fields' findings, continues to force the state to devote various efforts towards just renewable, 'green' energy, development. Yet the wind power produced in Israel is diminutive comparing to the continuously growing global market, however, the last steps undertaken by the state are destined to improve the situation. We study here installations, both for the solar and for wind energy, thus improving the diversity of energy sources. While the standard discounted cash flow (DCF) method using the net present value (NPV) criterion is widely adopted to the investment's evaluations, the standard DCF method is inappropriate for the rapidly changing investment climate and for the managerial flexibility in investment decisions. Consequently, in last period, the real options analysis (ROA) technique has been also widely applied in many studies for the valuation of renewable energy investment projects. Considering the above background, we apply at our study the ROA technique for the valuation of wind energy turbines and apply it to the analysis of wind energy economic potential in Israel, which is the context of our work. We assume that due to nature of wind energy production uncertainties, the ROA method is better than the alternative. The novelty of this paper includes the following: real world wind statistics of the Merom Golan site in Israel, a realistic power generation estimation, and an economic model to assess the feasibility of the considered project. We also discuss the rising challenges of diversifying renewable energy sources in Israel when adding wind installations. Our goal is to introduce a method which will allow investors and officials to take into account uncertainties when deciding in investing in the proposed wind installations. The outcomes of the paper, which are obtained using the Weibull statistics model and the Black–Scholes ROA technique, include the result that market price volatility adds to the uncertainties much more than any wind fluctuations, provided that the analysis is integrated over a long enough time. For the aims of the current study, we are interested in estimating the profitability of a Merom Golan wind facility. For this purpose: - We calculate the revenue from Merom Golan due to electric energy production; - We show that, taking into account the annual energy production, fluctuations are rather small; this is contrasted with rather large fluctuations when one considers the data over a daily basis; - This is then integrated into two economic models; one is the standard discounted cash flow and the other is the real options analysis; - We finally show that, because of energy price volatility and despite small technical fluctuations, the correct estimation of the investment is given by the real options analysis, which considers the ability of the investors to abort their investment after the first stage. We resume that our investigation presents the following innovative components: - Weibull statistics of the wind in Merom Golan based on data gathered for several years was obtained, thus deriving the relevant parameters needed for our work; - Using the empiric wind data and power curves of commercial wind turbines to choose the best wind turbine for the Merom Golan site; - Using the above data, we calculated the revenue from Merom Golan due to electric energy production; - We have shown that, taking into account the annual energy production, fluctuations are rather small; this is contrasted with rather large fluctuations when one considers the data over a daily basis. - The work was integrated into two economic models; one is the standard discounted cash flow, and the other is the real options analysis. We have shown that, because of energy price volatility and despite small technical fluctuations, the correct estimation of the investment is given by the real options analysis, which considers the ability of the investors to abort their investment after the first, from the both, stage. Prospective trends in the outlined research include the analysis of real economic parameters which are not only approximate estimates, and the use of more accurate analysis using approaches such as the binomial lattice, the mean reverting jump-diffusion method, as well as the stochastic volatility model.

References 1. Astolfi, D. Wind Turbine Operation Curves Modelling Techniques. Electronics 2021, 10, 269. [Google Scholar] [CrossRef] 2. Ahmed, D.; Ebeed, M.; Ali, A.; Alghamdi, A.S.; Kamel, S. Multi-Objective Energy Management of a Micro-Grid Considering Stochastic Nature of Load and Renewable Energy Resources. Electronics 2021, 10, 403. [Google Scholar] [CrossRef] 3. Ditkovich, Y.; Kuperman, A.; Yahalom, A.; Byalsky, M. Alternative Approach to Wind Turbine Performance Index Assessment. J. Energy Eng. 2014, 140, 06014001. [Google Scholar] [CrossRef] 4. Kolesnik, S.; Rabinowitz, Y.; Byalsky, M.; Yahalom, A.; Kuperman, A. Assessment of Wind Speed Statistics in Samaria Region. Preprints 2023, 2023010584 (doi: 10.20944/preprints202301.0584.v1). [CrossRef]

[8377] *A Deep Learning model based on Multi-Head Attention for long-term forecasting of solar activity*

Giovanna Jerse (INAF), Valentina Alberti (INAF), Adriana Marcucci (University of Trieste, Department of Physics), Isacco Zinna (University of Trieste, Department of Mathematics and Geo-science) and Mauro Messerotti (INAF).

The accurate long-term forecasting of solar activity is crucial in the current era of space explorations and in the study of planetary climate evolution. In fact, it supports the planning and prediction of future space missions, the determination of spacecraft orbits, and the estimation of satellite lifetime and is one of the main inputs to planetary atmosphere and Cosmic Rays models. With timescales of about 11 years, these forecasts deal with the prediction of the very general features of a solar cycle such as its amplitude, peak time and period. Solar radio indices, continuously measured by a network of ground-based solar radio telescopes, are among the most commonly used descriptors to characterise the solar activity level. They can act as proxies for the strength of ionising radiations, such as solar ultraviolet and X-ray emissions, that directly affect the atmospheric density. In a preliminary comparative study of a selection of univariate deep-learning methods targeting medium-term forecasts of the F10.7 index, we noticed that the performance of all the considered models tends to degrade with increasing timescales and that this effect is smoother when a multi-attention module is included in the used neural network architecture. In this work, we present a multivariate approach based on the combination of Fast Iterative Filtering (FIF) algorithm, Long-Short Term Memory (LSTM) network and multi-attention module, trained for the present solar cycle forecasting. Several solar radio flux time series, namely F3.2, F8, F10.7, F15, F30, are fed into the neural network to forecast the F10.7 index. The results are compared with the solar cycle forecasting based on the Sunspot Number (SN) available in the literature to highlight possible discrepancies.

[8415] *Energy transition in the U.S. commercial real estate: a diffusion comparison with the industrial sector.*

Andrea Savio (Georgetown University).

The paper deeply analyzes how the energy transition is developing in the U.S. commercial real estate sector, which has made significant strides in energy efficiency and sustainability in recent years. The study has been compared with the green energy diffusion of another exemplary and significant sector, i.e., the industrial one. The temporal diffusion of energy sources in the two industries has been analyzed to comprehend the intricate dynamics of energy systems through the multivariate diffusion model Unbalanced Competition for Three Technologies (UCTT). Critical parameter estimates denote a distinct evolution of the energy transition in the two sectors, especially for the green sources. The U.S. commercial sector's trend towards adopting green energy solutions is expected to persist as policy initiatives, private sector action, and market forces continue to decline the cost of renewable energy technologies and improve sustainability and energy efficiency in the real estate market. In the industrial sector, progress is occurring slowly, however. More excellent material and energy efficiency, more rapid uptake of renewable fuels, and faster development and deployment of low-carbon production processes are all critical requirements.

[8470] *Downscaling Fusion Model for CMIP5 Rainfall Projection under RCP Scenarios: the Case of Trentino-Alto Adige*

Amir Aieb (Faculty of Computer Science, Free University of Bozen-Bolzano, 39100 Bolzano, Italy), Antonio Liotta (Faculty of Computer Science, Free University of Bozen-Bolzano, 39100 Bolzano, Italy) and Ismahen Kadri (Department of Civil Engineering and Hydraulics, 24000 Guelma, Algeria).

Climate parameters projection obtained by global and regional models (GCM and RCM, respectively) offers a challenge to many researchers to control the quality of the outcome data using several scales. In the literature, the proposed models, namely statistical downscaled and regression-based models, are mostly used to adjust the RCM data series. Contrariwise in practice, these conceptual models perform poorly in certain cases and scales. In this regard, a new downscaling model is proposed herein for annual rainfall projection, based on fusion models, namely Polynomial Regression (Poly_R), Classification and Regression Tree (CRT), and Principal Component Regression (PCR). The proposed model downscales the rainfall data projected by the coupled model intercomparison phase five (CIMP5) under different representative concentration pathway (RCP) scenarios (2.6, 4.5, 6.0, and 8.5) using overlapping data between the observation and the CIMP5 historical data. This process aims to define the framework for how to use the output equations and algorithm to correct data forecasting by RCM. Generally, the model is summarized in three levels of analysis, starting with an iterative downscaling using a trendline model that is obtained by Poly_R fitting. Then, the CRT is used to classify and predict data in subsets. Finally, multiple regression is given by PCR model using principal components and standardized variables. The final model is also used to downscale predicted data obtained by both previous models. The results provide the best performance of the fusion model in all RCPs cases, compared to the Delta Change Correction and Linear Scale models. This performance is proved by R2 scores which range between 0.87 and 0.95.

[8479] *Revisiting The Dating of Financial Bubbles Via False Discovery Rate*

Gianmarco Vacca (Università Cattolica del Sacro Cuore), Giulia Genoni (Università della Svizzera Italiana) and Piero Quatto (Università degli Studi di Milano - Bicocca).

Detecting and dating financial bubbles is still an open question, and has attracted considerable attention in recent years. Phillips' tests, which are commonly employed for this purpose, involve a multiple testing procedure, with the consequence that the pertaining errors are more complex than those related to single hypothesis testing. This work revisits and improves Phillips' bubble detection method, exploiting the false discovery rate approach to guard against the issues posed by multiple testing, that is controlling for the expected proportion of true nulls that are rejected. An original formulation for the specific problem of bubble origination is thus proposed. In addition, an online false discovery-based approach is suggested for monitoring bubbles occurring in real time. The effectiveness of the proposed approaches is investigated via both a simulation study and an empirical application.

[8519] *Energy sector and stock market nexus: a dynamic PCA and wavelet-based mixed approach*

Marco Tedeschi (Università Politecnica delle Marche) and Paolo Canofari (Università Politecnica delle Marche).

Recent evidence suggests that investors have been looking for alternative hedging instruments against the growing uncertainty characterizing financial markets. A novel procedure combining dynamic principal component and wavelet analysis, is used to investigate the nexus between the stock market and the en- ergy segment. Specifically, during the pandemic crisis and especially from a medium-term perspective, we find evidence of increased co-movement between the uncertainty in the stock market and the renewable energy sector. Further, the presence of a structural break in the spectral behavior of the stock performance in the renewable energy sector signals the increasing relevance of this segment for investors' portfolio choices.

[8567] *Shock transmissions between crude oil prices, renewable energy stocks and sectoral indices*

Ana Escribano (Universidad de Castilla-La Mancha), Francisco Jareño (Universidad de Castilla-La Mancha) and Monika Koczar (Universidad de Castilla-La Mancha).

This paper investigates the equicorrelation and connectedness between crude oil future prices, energy conventional stocks, renewable energy stocks and several indexes capturing the performance of sectoral stocks in the U.S. during the period that ranges from July 31, 2014, to November 25, 2022. By applying a DECO-GARCH model and the connectedness measures from Diebold and Yilmaz (2012) we find that there exists a high degree of connectedness between crude oil prices, and the stocks and indexes studied for most of the period sample and that the connectedness is significantly pronounced during turmoil periods. Due to the Brent crude oil price (BRENT) sensitivity to shocks, the information is transmitted mostly from crude oil to other stock markets. The study shows that crude oil acts as a safe haven and a

hedge asset for renewable energy stocks. The study concludes with a detailed analysis of connectedness and equicorrelation in terms of the returns and volatility among crude oil prices and stock markets not only during different political and financial events but also in the aftermath of natural disasters that have affected the interdependencies between them. The results prove that the occurrences that influence the correlation between stock markets and Brent have no such significant impact, but the spillover effect of these events dissolves at a leisurely pace.

[8574] *Evaluation of models for predicting the occurrence of visceral leishmaniasis in 09 Brazilian states, 2001 to 2017: an ecological time series study*

Marcos Venicius Malveira de Lima (Acre State Department of Health) and Gabriel Zorello Laporta (Postgraduate Sector, Research and Innovation).

Objective: to evaluate the predictive ability of different time series models of visceral leishmaniasis cases in nine Brazilian states, 2001-2017. Methods: This is an ecological time series study with cases of visceral leish-maniasis recorded in the states. Ten deterministic or stochastic statistical models were used for simulation and testing at forecast horizons of 3, 6 and 12 months. Results: The initial test showed that the series is stationary. The deterministic models performed better than the stochastic models. Prediction of future cases of visceral leishmaniasis at horizons of 6 - 12 months ahead was possible. Conclusion: The use of deterministic models is recommended for the prediction of future scenarios and for the anticipation of planning in the health services of the Brazilian states

[8577] *Impact of the Covid Pandemic on Global Ecotourism : A Critical Analysis*

Kanupriya Kanupriya (Sri Aurobindo College, University of Delhi, India) and Kanupriya Kanupriya (IIFT Delhi).

The Covid-19 pandemic has been a game changer in more ways than one. This article seeks to evolve a critical perspective on the impact of the pandemic on the global ecotourism sector. For the purpose, instances from all the major continents of the world such as Asia (India), Africa (Morocco), North America (USA), South America (Brazil), Europe (Portugal) and Australia are employed as cases to undertake an impact analysis-centric study. The selection of these countries has been done solely on the basis of available statistical and literary evidence. That the ecotourism sector is vital for sustainability within the tourism industry and that it builds on the basic principles of local procurement while assimilating local cultures and bringing the much needed gainful employment opportunities for local communities without causing harm to the natural environment is what constitutes the uniqueness of this industry. The same also sets it apart from the traditional approaches to tourism thereby, marking its presence in the realm of circular economy. Apart from this, it is also known that ecotourism needs concerted efforts from all stakeholders to ensure its everlasting success. This article also seeks to study the prospects for the same in the context of the pandemic, using examples from the countries mentioned above. The methodology for this work is by and large review of literature and simple correlation analysis. This has aided the author in formulating an informed opinion on an issue of such vital importance, yet often overlooked in traditional economic research. Policy implications of this research include development of alternative tourist destinations, regulating and penalising illegal construction activities, promoting theme-based tourism, imposing restrictions on tourist entry into ecologically sensitive regions and capacity building of small tourism service providers. All in all, adopting a circular economic approach towards this circular tourism alternative could surely go a long way in containing the negative fallout of the pandemic and also help the sector gain greater strength and resilience for future times to come.

[8605] *Threatening and threatened: How forecasting distribution of species under changing climate helps in biodiversity conservation*

Achyut Kumar Banerjee (Sun Yat-sen University) and Yelin Huang (Sun Yat-sen University).

Biodiversity, the fabric of life on earth, is declining at an unprecedented rate. The recent loss of biodiversity is leading to subsequent declines in ecosystem functioning and stability, thereby leaving grave impacts on people worldwide. The most significant direct drivers causing this steep decline are massive land-use changes, climate change, pollution, resource use and exploitation, and invasive species. Besides being a driver, climate change can also interactively influence the other drivers of biodiversity loss.

The climate conditions primarily determine the establishment success of a plant species in a new environment. Therefore, changes in climate conditions alter the species' distribution patterns in the form of range expansion

(establishment of species in a new region) or contraction (local extinction of a species from a region). Species distribution models (SDMs) are, therefore, often used to identify climatically suitable (or unsuitable) areas for a species. In this presentation, I will focus on one of the causes (biological invasion threatening global biodiversity and economy) and consequences (loss of ecosystem services provided by the mangroves) of biodiversity loss and highlight how predictive modeling of species distribution can address the interconnected crises of climate change and biodiversity loss.

Biological invasion is a defining feature of the Anthropocene, causing severe impacts on native species, ecosystems, and human well-being. Recent studies have identified that invasive alien species (IAS) caused economic damages worth trillions of dollars globally. The rate of new introductions is increasing, and the impacts of IAS can be compounded by climate change which can facilitate the spread and establishment of alien species. Therefore, the United Nations Convention on Biological Diversity has considered the management of IAS as one of the 23 targets to be achieved by 2030 to address the loss of biodiversity and restore natural ecosystems. In this presentation, I will focus on the halophyte smooth cordgrass (Spartina alterniflora), the introduction and spread of which is considered one of the largest continental-scale biological invasion events in Asia and the Americas. Rapid globalization and broad environmental tolerance of the species increase the chance of novel invasions. This study aimed to identify regions susceptible to the species' establishment to inform prevention and control activities. A comprehensive global occurrence dataset and 19 bioclimatic variables were used to characterize the species' climatic niche and predict current and future potential distributions. The conservatism of climatic niche between native and non-native ranges was tested, and climatic niche dynamics were analyzed at spatial and temporal scales. The ensemble of eight species distribution models and eight climate change models was used to map the potential distribution of the species under current and future climate conditions. For future climate projections, we compared the predictions between nine Global Climate Models (GCMs) of the CMIP6. We chose the GCMs for two climate change scenarios where there would be severe and marginal increases in precipitation in addition to the temperature increase. The models were fitted for two shared socio-economic pathways for three distant future time periods. In addition, we investigated the susceptibility of threatened ecosystems like mangroves and protected areas to S. alterniflora invasion to inform management decisions better. Our study revealed wide climatic tolerance and significant niche expansion of the species from humid regions of its native range to dry and arid environments of its non-native range with a very short lag period. With a marginal increase in temperature and precipitation in the future, range expansion was predicted towards higher latitudes and more inland areas. The mangrove area, salt marshes, and protected areas that are at risk of ongoing and future invasions were identified. Given the invasion potential of S. alterniflora, we emphasized that the areas identified as climatically susceptible to the species' establishment, both in current and future climates, should be prioritized for management actions.

The mangroves are the dominant plant community in the tropical and subtropical intertidal region and provide a wide range of essential ecosystem services for coastal human livelihood. For the past few decades, these valuable ecosystem service providers have been substantially lost due to climate change and human activities. So severe was the decline that 'a world without mangroves' was predicted without conservation measures. However, conservation success is regionally variable, and mangrove hotspots, especially in developing countries with limited response capacity, are at the same or even higher risk of loss. In this study, we aimed to identify the species and areas which should be prioritized for conservation in the Indo-West Pacific (IWP) region, one of the two global hotspots of mangroves (another is the Atlantic East Pacific region). We selected ten species, including true mangroves (i.e., species occurring only in tidal swamps and possess specialized morphological and physiological features) and mangrove associates (i.e., species distributed in terrestrial or aquatic habitat but can also occur in the mangrove ecosystem and lacks the specialized features). We used a robust occurrence data set and 30 environmental variables in an ensemble modeling framework to map the potential distribution of these species in current, past, and future environmental conditions. The ensemble framework was built on eight individual species distribution models of different statistical complexities. The future and past environmental conditions were simulated for two general circulation models, two IPCC greenhouse gas concentration pathways, and two paleoclimate conditions. The priority targets were then identified through a weighted-scoring approach with the current distribution and the modeled outputs. Our study revealed that precipitation and surface elevation could influence the distribution of the true mangroves, while the temperature was the important variable for the mangrove associates. Five of the studied species were found to have the highest priority score for conservation. Although suitable habitat for the mangroves is predicted to increase in the future, primarily due to the northward range expansion of six species, areas with high species richness would decrease. We found 7.09% and 4.16% of areas of the IWP should be prioritized for conserving the true mangroves and mangrove associates, respectively. The characteristics of these priority sites indicated that the inclusion of the anthropogenic component in the conservation framework and species-targeted management plans in the protected areas are required to implement conservation actions effectively. The glacial refugia of the species, primarily distributed in the Philippines, New Guinea, southern India, and Madagascar, should be explored further for species-specific conservation actions.

These two case studies demonstrated the ability of predictive modeling to safeguard biodiversity by taking proactive management and conservation actions. However, the SDM techniques are based on the assumption that a species retains its climatic preferences between different geographic areas or time periods. Still, scientific evidence exists in support and against this assumption. Moreover, the accuracy of predictive modeling depends heavily on the input data resolution. Therefore, a priori testing of the assumption and validating the model outputs based on a robust model validation framework are needed to achieve better predictive modeling accuracy and improve the outputs' interpretability. This presentation will highlight how we tested the assumption and validated the model outputs for the two case studies and, therefore, will provide an idea of the holistic approach needed for future predictive modeling studies.

[8677] *Addressing the multiple dimensions of poverty: Dimensionality Reduction with t-Distributed Stochastic Neighbor Embedding (tSNE) Algorithm*

Amine Amar (School of Science and Engineering, Al Akhawayn University, Ifrane).

The existence of extreme poverty is considered as a critical challenge. However, while there is world-wide agreement on poverty alleviation as an overriding goal of development policy, there is little agreement on the definition and measurement of poverty. As outstanding examples, we can mention the monetary, capability, social exclusion and participatory approaches. The monetary approach; which is considered as the most commonly used one, identifies poverty with a shortfall in consumption from some poverty line. The capability approach rejects monetary income as its measure of well-being, and instead focuses on indicators of the freedom to live a valued life. In this framework, poverty is defined as deprivation in the space of capability approach, or failure to achieve certain minimal or basic capabilities. Compared with these two approaches, the dynamic focus and an emphasis on the processes that engender deprivation are two distinguishing features of the social exclusion approach, while the participatory approach aims to get people themselves to participate, in decisions about what it means to be poor and the magnitude of poverty. However, the multidimensional approach still the most important and practical instrument for poverty alleviation. Thus, multidimensional poverty encompasses the various deprivations experienced by poor people in their daily lives, such as poor health, lack of education, inadequate living standards, disempowerment, poor quality of work, the threat of violence, and living in areas that are environmentally hazardous, among others. This approach incorporates a range of indicators that capture the complexity of poverty in order to inform policies. In this context, different measures were suggested. We can mention for example the multidimensional poverty measure (MPM), developed by the World Bank, which seeks to understand poverty beyond monetary deprivations, by including access to education and basic infrastructure. However, many challenges and shortcomings still exist, especially in how to correctly interpret and extract relevant information about poverty from complex data. This makes interpretation of the data difficult, and thus, the need to reduce the dimension without losing critical information becomes an important task. Literature provide a wide variety of dimensional reduction techniques, and which are used for a wide range of datasets. To cite only a few examples, we must consider the approach initially suggested by Pearson. This method projects the data to a linear hyperplane minimizing the orthogonal distance between the plane and the data points. However, this is restricted to linear data sets, which makes it limited in its applicability as data sets are often have a non-linear structure. Since then, many new methods have been developed that are able to deal with non-linear data (complex data). The following figure, figure1, presents the most common techniques, used for dimensionality reduction and distinguishes between feature selection and dimension reduction. The feature selection aims to reduce the number of input features by using statistical techniques, to identify the best and most relevant features, and excluding irrelevant features in the dataset for the predictive models. By contrast, the goal of dimensionality reduction is to reduce the high-dimensional space to a lower-dimensional space by creating new features from original features with minimum information loss.

In this paper, we will address the gap by using a particular variant of Stochastic Neighbor Embedding (SNE), called the t-Distributed Stochastic Neighbor Embedding (t-SNE) algorithm, to define a composite multidimensional poverty measure. The algorithm starts by converting the high dimensional Euclidean distances between data points into joint probabilities that represent similarities. To implement our approach, we use time series from the World Development Indicators (WDI) website (https://databank.worldbank.org/source/world-development-indicators), to extract information about 7 African counties. The 15 used time series cover social, demographic, environment, economic, and governance aspects. The extracted index based on t-SNE algorithm is compared with a conventional multidimensional poverty index and results shows a good matching

[8684] *Opportunistic Scheduling-based forecasting Strategies for Efficient Resource Utilization in New Telecommunication Networks*

Mohamed Ouwais Kabaou (Universiy of Gabes), Nesrine Zoghlami (University o Tunis El Manar), Fatma Baabou (University of Gabes) and Hassen Hamouda (Al Majmaah University).

The purpose of this research paper is to investigate radio resource allocation using scheduling and opportunistic techniques. This enables a comparison of service quality provided to users transmitting heterogeneous traffic, and allows for effective evaluation of resource allocation algorithms and schedulers. Various scheduling algorithms, such as Round Robin, MaxSNR, and PF, are employed for resource allocation and scheduling. The main aim of this study is to analyze and develop performance metrics in MATLAB, associated with schedulers used by telecommunication operators. It is important to note that scheduling is a crucial phase that precedes the allocation of radio resources in a mobile radio telecommunications system. This paper will focus on the advantages and contributions of opportunistic scheduling techniques in conjunction with conventional approaches, and provide recommendations for improving resource utilization and enhancing performance in terms of throughput and fairness for telecommunication operators.

[8688] *A proposal of Transfer Learning for monthly macro-economic time series forecast.*

Martín Solís (Instituto Tecnológico de Costa Rica) and Luis-Alexander Calvo-Valverde (Tecnológico de Costa Rica).

Transfer learning has not been widely explored with time series. However, it could boost the application and performance of deep learning models for predicting macroeconomic time series with a few observations like monthly variables. In this study, we propose to generate a forecast of five macroeconomic variables using deep learning with transfer learning. The models were evaluated with cross-validation on a rolling basis, and the metric MAPE. According to the results, deep learning models with transfer learning tend to perform better than deep learning models without transfer learning and other machine learning models. The differ-ence between statistical models and transfer learning models tends to be small. Although, in some series, the statistical models had a slight advantage in the per-formance metric, the results are promising about applying transfer learning in mac-roeconomic time series.

[8698] *The optimal share of solar energy in an energy island*

Ofira Ayalon (University of Haifa), Tsur Moshe (PhD student at University of Haifa) and Yaniv Reingewertz (University of Haifa).

Many countries have committed to high levels of renewable energy (RE), yet, electricity islands face challenges that impose additional costs to meet high penetration levels of RE. We suggest a wide-ranging cost–benefit analysis of power generation, current and projected land and transmission costs, fossil fuel and solar installation costs, storage costs, and externalities from power generation to assess the optimal electricity generation mix in 2050 in an energy island. Our baseline estimates suggest that about 45% of the energy mix in Israel can depend on solar power and the remainder on fossil fuels. At less than a 30% penetration rate, there is no need for daily storage if there are no transmission limitations. Yet, if the country commits to higher levels of RE- up to 56% renewables, there is no need for inter-monthly storage. Our analysis shows that for the reserve conditions presented, the maximum penetration rate of renewable is about 80% even if benefits exceed costs at higher penetration rates. Sensitivity analyses suggest an optimal solar power penetration rate between 31 - 47%, depending on set-up and storage costs.

[8707] *An Application of Ensemble Spatiotemporal Data Mining Techniques for Rainfall Forecasting*

Shanthi Saubhagya (University of Colombo), Chandima Tilakaratne (University of Colombo), Musa Mammadov (Deakin University) and Pemantha Lakraj (University of Colombo).

An accurate rainfall forecasting plays a vital role in detecting the future flood occurrences. Consecutive rainfall for a longer period may result in a high chance of flooding in vulnerable areas while extreme rainfall triggers flash flood events devastating lives of humans as well as animals and creating significant property damages. To alleviate the losses due to flood, this study proposes an ensemble methodology for short term rainfall forecasting using data mining techniques. The method captures the in-built spatiotemporal and imbalanced characteristics of rainfall data. Initially, Spatial Kriging

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prediction for the target station was obtained using daily rainfall and geo-location data of six nearby gauging stations. Further, a Deep Learning model was fit-ted with daily satellite data at target location to predict rainfall occurrence. Then, three days prior values of these two predictions and other weather-related variables were fed into six machine learning models, namely, Penalized SVM, Complement Naïve Bayes, and Cost-Sensitive MLP, LSTM, Logistic Regression, and Random Forest to compute final forecasting of rainfall occurrences. The results were compared in terms of several metrics including accuracy, precision, and Recall. Penalized SVM, Cost-Sensitive Logistic Regression, Random Forest, and LSTM models performed better than other considered models. Then, those selected models were refitted after applying Synthetic Minority Oversampling Technique to further address the class imbalance issue. The Cost-sensitive Oversampled Random Forest method showed the highest test accuracy, precision, recall and an F1-score of 0.87. Furthermore, the evaluation of the models using an extended period of data set evidenced that this best model outperformed the other models by resulting in the highest accuracy of 0.87 and the highest precision, recall and an F1-score of 0.88. Therefore, the study suggests the suitability of our pro-posed ensemble spatiotemporal rainfall predictive model in accurate classification of rainfall data which are highly imbalanced by its nature. The follow-up studies should be conducted to verify its generalizability with larger data sets and dimension reduction, and applicability should be tested using spatiotemporal series.

[8733] *Hyperautomation in Supershop using Machine Learning*

Shuvro Ahmed (BRAC University), Joy Karmoker (BRAC University), Md. Mahamudur Rahman (BRAC University), Rajesh Mojumder (BRAC University), Shadman Fatin (BRAC University), Dr. Md. Golam Rabiul Alam (BRAC University) and Tanzim Reza (BRAC University).

The purpose of this research is to determine how best to use hyper-automation technology to optimize both customer and seller experiences in super shop. Here, a smart bot is employed to speed up responses to simple consumer questions by utilizing natural language processing in real time. We also used machine learning frameworks such as XGBoost, Linear Regression, Random forest, and hybrid models, together with daily sales data, to make predictions about future product demand. In addition, data mining methods including the Apriori algorithm, FP Growth algorithm, and GSP algorithm will be utilized to guarantee optimal product placement.

[8785] *Model Structure Determination for Sparse ARDL Models under High Dimensional Design Matrices*

Livio Fenga (University of Exeter).

Big Data matrices are becoming more and more a common place when secondary data are employed. By design, secondary data are not purposely collected for the intended research task and therefore often convey a limited amount of useful information. A common coping strategy for this situation is to include in the set of explanatory variables also those variables that can account for only a small portion (or even a fraction) of the total variations in the dependent variable. As a result of that, a big data design matrix is generated. However, in many instances, the exploitation of a dataset containing a great number of variables has many drawbacks, the most important one being associated with the extraction of only the relevant portion of the whole information set (usually a small subsample of the original dataset). Such a task becomes even more complicated in time domain, given the "physiological" inclusion in the design matrix of the lagged versions of all the available variables. But this is not the whole story. In fact, lag sparsity of the design matrix is very likely to happen in such a setup, which should always be considered. Accounting for sparsity in the vector of coefficients, however, almost surely increases the (already high) level of uncertainty surrounding the whole analysis.

The present paper aims at developing a method designed to enhance the variable selection procedure for Auto Regressive Distributed Lag (ARDL) models affected by high degrees of uncertainty induced by lack of parsimony in the original design matrix. Usually, ARDL models can efficiently accommodate a "small" number of independent lagged variable, how small depending on both the number of independent variables being investigated and the number of significant lags needed to be accounted for in the final model. The proposed dimension reduction procedure focuses on a model of the type of ARDL, which is envisioned to work in conjunction with a LASSO (Least Absolute Shrinkage and Selection Operator) method for the efficient suppression of the irrelevant information (that is the greatest part of the data matrix) not only by constraining the variables space but also the lag-space. While the former is based on a pure LASSO method, the latter relies on a novel criterion, which is aimed at discovering lag-consistency in the variables extracted by the LASSO procedure in the first place. The rationale is as follows: noisy and otherwise corrupted signals might generate many false relevant lags. Essentially, false positives are those lags which play no role in explaining the

variability of the time series of interest and, if included in the final model, can generate many types of unwanted phenomena, e.g., degradation of the forecasting performances or noise. Especially with large data sets, it is vital to control for such a risk, and given the large number of time series involved, there are proportionally higher chances of selecting "bad" time series. To reduce the probability of inclusion of false positives in the final model, the envisioned lag-consistency detection procedure selects only the variables showing at least k=1, 2,…,K significant coefficients (in the LASSO sense), k being arbitrarily selected, usually according to the number of variables resulting from the first round of selection. The theoretical justification of the method has been caried out using the multivariate t-distribution for dependent data. This distribution, which has a quite complex mathematical form, allows first the formalization of multiple dependent variances for multi-lag significant variables and secondly the theoretical proof of the validity of the proposed method. The studied procedure can be applied to carry out investigations on several complex phenomena, such as stock market or macroeconomic variables. A set of simulations have been carried out on the ISTAT (the Italian Office for National statistics) dataset comprising sentiment indicators for the different economic activities classified according to the NACE (Statistical classification of economic activities in the European Community) classification.

[8802] *Foreing Exchange forecasting models: ARIMA and LSTM comparison*

Fernando García (Universitart Politècnica de València), Francisco Guijarro (Universitat Politècnica de València), Javier Oliver (Universitat Politècnica de València) and Rima Tamošiūnienė (Vilnius Gediminas Technical University - VILNIUS TECH).

The prediction of currency prices is important for investors with foreing cur-rency assets, both por speculation and for hedging exchange rate risk. Classi-cal time series models such as ARIMA models have been relevant until the advent of neural networks. In particular, recurrent neural networks such as the Long Short-Term Memory (LSTM) are shown to be a good alternative model for the predictions of short-term stock prices. In this paper, we present a comparison between the ARIMA model and LSTM neural network. A hy-brid model that combines the two models is also presented. In addition, the effectiveness of this model on the bitcoin futures contract is analysed.

[8807] *Fuzzy combining forecasts instead of lag length selection in predicting price move direction*

Aleksandra Rutkowska (Poznań University of Economics and Business) and Jakub Morkowski (Poznań University of Economics and Business).

The extended abstract is attached

[8929] *Clustering of time series based on forecasting performance of global models*

Ángel López-Oriona (Universidade Da Coruña).

This article proposes a new procedure to perform clustering of time series. The approach relies on the classical K-means clustering method and is based on two iterative steps: (i) K global forecasting models are fitted via pooling by using the series belonging to each group and (ii) each series is assigned to the cluster associated with the model yielding the best forecasts in accordance with a specific criterion. The resulting clustering solution includes groups which are optimal in terms of overall prediction error, and thus the procedure is able to detect the different forecasting patterns existing in a given dataset. Some simulation experiments show that our method outperforms several alternative techniques in terms of both clustering accuracy and forecasting error. The procedure is also applied to carry out clustering in three real time series databases.

[8945] *Approximation of Weymouth Equation using Mathematical Programs with Complementarity Constraints for Natural Gas Transportation*

Cristian Blanco-Martínez (Universidad Tecnológica de Pereira), David Augusto Cardenas-Peña (Universidad Tecnológica de Pereira), Mauricio Holguín-Londoño (Universidad Tecnológica de Pereira), Andrés Marino Álvarez-Meza (Universidad Nacional de Colombia) and Alvaro Angel Orozco-Gutiérrez (Universidad Tecnológica de Pereira).

Environmental demands around the world have led to an increasing interest in natural gas due to its advantages over other hydrocarbons used in power generation, which has led to the search for the best way to solve the transportation problem associated with this resource. In this paper, we propose a methodology that allows us to address the non-convexity related to the Weymouth equation that makes the optimization problem so difficult. The mentioned equation, in charge of relating the flows through the pipelines and the pressures at the nodes, is characterized by having a discontinuity in the form of a sign function. The proposal of this work is based on the use of Mathematical Programs with Complementarity Constraints (MPCC) to achieve a good approximation since it allows make certain continuous variables to behave as discrete variables in such a way that it is possible to avoid having to pose a mixed integer programming problem and this one. This approach showed a smaller approximation error (or at least equal) with other approximations used in the state of the art when tested in three different networks: one of 8 nodes, one of 48 nodes tested in other related works, and one of 63 nodes representing the Colombian natural gas transportation system.

[8953] *ICTs and Economic Growth: The case of South Africa (1990 to 2021)*

Simion Matsvai (University of Fort Hare), Amon Taruvinga (University of Fort Hare) and Willie Chinyamurindi (University of Fort Hare).

Driven by the COVID-19 pandemic experiences, economic digitalization and embracing the fourth industrial revolution (4IR) became imperative. However, for economic digitalization and the 4IR to be successful, Information and Communication Technologies (ICTs) tend to form both the necessary and sufficient conditions. The study examined the relationship between ICTs and economic growth in South Africa for the period 1990 to 2021. The impact of ICTs was captured by mobile cellphone subscriptions, fixed telephone subscriptions, internet connectivity and ICT infrastructure. A Cobb-Douglas production function model form was estimated with the conventional determinants of economic growth (investment, government expenditure, human development, inflation, exchange rate and trade openness), governance variables (corruption and trade openness) and an environmental variable (climate change). Four models with ICT variables (mobile cellphone subscriptions, fixed telephone subscriptions, internet connectivity and ICT infrastructure) were estimated using the ARDL Bounds test for cointegration approach. Empirical results revealed significant positive impact of mobile phones subscriptions, internet connectivity and ICT infrastructure on economic growth together with the other traditional determinants of economic growth such as investment (gross fixed capital formation), labour (HDI) and government expenditure. Contrastingly, climate change, corruption, inflation, exchange rate and fixed telephone subscriptions were found to have negative externalities on economic growth together with their first lags except for fixed telephone subscriptions. Therefore, mobile phone subscriptions, internet connectivity and ICT infrastructure play significant roles in the digitalization and growth of the South African economy. To promote sustainable and inclusive economic growth, policy insights included the expansion of ICT infrastructure (mobile cellphone infrastructure and internet connectivity) for universal access and also the regulation of prices to increase both access and affordability thereby embracing the 4IR.

[9062] *METHODS AND SCENARIO ANALYSIS INTO REGIONAL AREA PARTICIPATORY PLANNING OF SUSTAINABLE DEVELOPMENT. THE "ROSES VALLEY" SOTHERN MOROCCO, A CASE STUDY*

Tiziana Vitolo (Istituto di Studi sul Mediterraneo), Antonio Bertini (UNITRE) and Immacolata Caruso (Istituto di Studi sul Mediterraneo).

As the global environmental crisis grows in scale and complexity, land protection experts and policy-makers are increasingly called upon to make decisions, despite high levels of uncertainty, limited resources and insufficient or conversely available but unintegrated data. Efforts to protect biodiversity at the national and especially local level, to achieve sustainable development of territories and their communities, require the incorporation of social, economic and political considerations into participatory planning of strategies adopted and to be undertaken. With this in mind, the geographical focus chosen in this contribution is the territory of the Valley of Roses in the southern part of Morocco. From a methodological point of view, it will address the state of the art of the existing literature on sustainable development and the good practices implemented in those territories. The final objective about the application and resolution of real problems, concerns on the one hand the possibility of valorising the material and immaterial cultural heritage and on the other hand identifying the steps to be taken in a long-term vision aimed at identifying concrete actions for the valorisation and development of the area.

[9119] *A Semi-parametric Transition model For Lifetime Drift of Discrete Electrical Parameters in Semiconductor Devices using Accelerated Stress Test Data*

Lukas Sommeregger (Infineon Technologies Austria AG) and Horst Lewitschnig (Infineon Technologies Austria AG).

In automotive industry, safety and quality guarantees to customers are of utmost importance. The advance in self-driving technologies offers new challenges for semiconductor manufacturers with the rise in expected usage times in vehicles and the opportunities for predictive maintenance. The topic of prognostics and health management (PHM) deals with early detection and handling of deviations during operations. Transistors in devices degrade over their lifetime. To simulate this, the lifetime of a random sample of parts is simulated in so-called accelerated stress tests. During these tests, parts are put to increased environmental conditions to simulate aging. Over the course of the stress test, electrical parameters are measured at certain readout times, then parts are stressed again and so on. The result is a time-censored set of longitudinal data. The change of the parameters over their lifetime is called parameter drift. From this sample, the lifetime drifts of the electrical parameters are calculated. Then, before shipping, all parts are tested at the so-called production testing. Based on the calculated results, tighter test limits are introduced to control for lifetime drift. Parts outside of these test limits are not shipped. The area between the test limits and specified limits is called guard band. The aim of this process is to guarantee quality to the customer and to maximize yield for the producer. Statistical models for lifetime drift are needed to guarantee reliability targets to the customer. In previous works, by Hofer et. al. and Lewitschnig et. al., models have been developed to deal with lifetime drift of continuous parameters. However, in the case of discrete-only parameters, such as bit-flips, count data, or in the case of low tester resolution, no comparable models exist. We propose both a semi-parametric model based on transition modeling using non-parametric estimators for the conditional transition distributions and an adaptation to existing models in the case of a discretized continuous parameters. The transition model is based on a Markov Chain approach assuming homogeneous increment distributions. It is corrected for measurement (GR&R) errors. Interpolating between known readout points is achieved via a combination of a linear change model and non-parametric density estimation. The issue of optimal guard bands is discussed as an integer optimization problem with non-linear constraint conditions and solved via efficient use of matrix multiplication and intelligent warm starts obtained from one-sided solutions. Extrapolation of future behavior via interval estimation of residual useful life (RUL) is discussed using both natural extensions of the transition model and quantile regression methods. The results are verified using simulation studies and compared to existing models.

[9126] *An intraday portfolio performance analysis of cryptocurrencies as diversifiers for Forex investors*

Carlos Esparcia (University of Castilla-La Mancha) and Raquel López (University of Castilla-La Mancha).

This study identifies and assesses the diversification benefits of including large-cap and highly liquid cryptocurrencies into portfolios comprised of major fiat currencies quoted against the USD. We employ hourly data over the period from January 01, 2019 to May 31, 2021. We identify hedging properties across crypto-currency pairs based on intraday volatility fitting through multiplicative component Generalized Autoregressive Conditional Heteroscedasticity (mcGARCH) models and the estimation of Dynamic Conditional Correlation (DCC) Skew Student Copulas. We find that the optimal diversified crypto-Forex portfolio outperforms the actively and passively managed Forex portfolios based on both total risk and downside and upside risk performance measures. Outperformance is robust to different market conditions.

[9270] *Forecasting the tails of financial indexes distributions*

Massimiliano Frezza (Sapienza University of Rome).

It is unanimously recognized that the unconditional distributions of financial log-returns are characterized by tails fatter than those prescribed by ordinary Gaussian distributions. In fact, market crashes generating such tails occur many more times than one should normally expect; witnesses are the recent global financial crises due to banking collapses, wars and/or pandemics. This characteristic, well-known as one of the stylized facts outlined by Cont (2001), is generated

primarily by the fact that market volatility tends to vary over time, clustering in particular market situations. Alternative approaches have been proposed in literatures with the aim of identifying a model capable of obviating this problem. Among them, the best known are the ARCH/GARCH family or the stochastic volatility models. Special interest has also been directed toward (multi)fractional models. Originated with the fractional Brownian motion (fBm), introduced in 1968 by Mandelbrot and Van Ness (Ness)[1], they have been first generalized with the multifractional Brownian motion in 1995 [2]and later with the Multifractional Process with Random Exponent (MPRE) in 2005 [3]. In fact, allowing the Hurst parameter H of fractional Bwnian motion, which characterizes the dynamics of fbm (antipersistent if 0<H<1/2, persistent if 1/2<H<1 or uncorrelated ordinary Brownian motion if H=1/2), to vary over time and become an Hölderian function H(t), the mBm was introduced by Lévy-Véhel and Peltier in 1995. The advantage of this process in certains applications lies in the fact that it is capable of describing dynamics whose regularity varies over time, such as, for example, the price process in financial markets. The natural extension of mbm allows to the memory function H(t) of an mBm to become a random variable or even a stochastic process S(t,ω). This extension, developed in 2005 by Ayache and Taqqu, is able to generate surrogates for the development of predictions about future dynamics. This is precisely the focus of this work. Assuming that S(t,ω) can be described by an autoregressive process of order λ, surrogates of the log-returns of three main stock indexes - Standard & Poor 500 (S&P500), the Euro Stoxx 50 (SX5E), and the Nikkei 225 (N225) - are generated and their distributions are analyzed. In particular, we first examine the dynamics of actual international indexes in terms of volatility and regularity by exploiting a Moving Window Absolute Moment (MWAM) estimator [4] and then examine the tails of log-indexes distributions comparing the quantiles of surrogetes and actual trajectories. Furthermore, assuming that the distributions of kurtosis follow a Generalized Pareto Distribution (GPD), the corresponding tail indexes of both series – actual and surrogates - are compared.

[9282] *Probabilistic Forecasts for Solar Irradiance using WRF-Solar Ensemble Prediction System*

Saurabh Verma (Indian Institute of Remote Sensing) and Charu Singh (Indian Institute of Remote Sensing).

Solar technologies are seen as viable choices for decreasing greenhouse gas emissions and supporting long-term adaptation in the context of climate change and increased energy demand. Reliable probabilistic solar radiation information is necessary to improve the management of the uncertainty and unpredictability of solar radiation. Thus, the development of skilled and dependable ensemble predictions is critical, and it will ultimately help the integration of large amounts of solar energy on the grid. The objective of this study is to investigate the direct and indirect effect of Aerosol Optical Depth (AOD) and Land Use and Land Cover (LULC) change on solar irradiance over north western Himalayas. For that purpose, the AOD and LULC data set from MERRA-2 and Bhuvan have been ingested into the Weather Research and Forecasting-Solar Ensemble Prediction System (WRF-Solar EPS), developed by National Renewable Energy Laboratory (NREL). The WRF-Solar EPS generate ensemble members for intraday or day-ahead solar irradiance forecast based on stochastic perturbations. The characteristic of stochastic perturbations is derived by selecting an isotopic Gaussian distribution for variables that are most sensitive and control radiative transfer and cloud processes, such as surface albedo, AOD, Angstrom exponent, asymmetry factor, water vapour/cloud/ice/snow mixing ratios, ice number concentration, potential temperature, turbulent kinetic energy, soil moisture content, soil temperature, and vertical velocity. The results suggest that the ensemble forecast increases forecast quality by accounting for the uncertainty of each ensemble member. Overall, The EPS has helped to reduce positive bias and improve probabilistic properties like dependability and statistical consistency.

[9310] *Forecasting Short-Term Dredging Needs with Machine Learning Models at Southwest Pass*

Magdalena Asborno (Applied Research Associates for USACE), Jacob Broders (Applied Research Associates), Kenneth Mitchell (U.S. Army Engineer Research and Development Center), Michael Hartman (U.S. Army Engineer Research and Development Center) and Lauren Dunkin (U.S. Army Engineer Research and Development Center).

The primary outlet for the Mississippi River at the Gulf of Mexico, known as Southwest Pass (SWP), is one of the most highly utilized commercial deep-draft waterways in the United States. Disruptions in navigation due to hard-to-predict accumulation of sediments in SWP affect the access of deep-draft vessels to four of the nation's top 15 ports measured by tonnage that connect the U.S. Midwest with global markets, and handle around 500M tons of cargo annually. The SWP is maintained by the U.S. Army Corps of Engineers (USACE) at a depth of 50 feet. The USACE spends on the order of $100M annually on dredging operations to maintain a reliable shipping channel throughout SWP, and the unpredictability of rapid-onset shoaling has been known to drive annual costs to more than twice that amount (Hartman, et al., 2022).

Presently, USACE New Orleans District project managers rely on rules of thumb with seasonal river stage trends and thresholds to get 10-14 days of lead time for shoaling conditions at SWP. This work covers the development of a machine learning regression model to increase both the lead times for and accuracy of shoaling forecasts and associated dredging requirements in SWP. The machine learning regression models are embedded in a multi-variate, multi-step time-series forecasting framework. Results obtained with a Random Forest (RF), and two Artificial Neural Networks (ANN) (a Multi-Layered Perceptron (MLP), and a Long Short Term Memory (LSTM)) are compared, for different scenarios of input days, to forecast 45-day channel shoaling volumes. An increase trend in daily shoaling values indicates a need to mobilize dredges to the SWP area. Model performance is evaluated with normalized Root Mean Squared Error (nRMSE). In the absence of metrics to evaluate the state of the practice, an univariate Auto-Regressive Integrated Moving Average (ARIMA) model is used as baseline.   The variable to predict is based on daily volumes of sediment accumulated in the 35-mile stretch of the Mississippi River between Mile 13.4 Above Head of Passes, and Mile 22 Below Head of Passes. Historical values of sediment accumulated on SWP between 2012-2022 are obtained from the Corps Shoaling Analysis Tool 2.5 (CSAT) (Dunkin, Coe, & Ratcliff, 2019), and used as proxy for dredging needs. This time-series is not stationary, thus CSAT estimates were transformed to 7-day rolling averages. The result is used both as variable to predict and input to the forecasting model.   Following a physics-informed approach, the data preselected to feed the time-series forecasting model is in line with variables that may affect shoaling (USGS, 2018) (Nel, Dalu, & Wasserman, 2018). In addition to the variable to predict, 99 potential input variables were considered. One of them was the week of the year when the data was collected. In addition, a pool of 98 variables from 57 stations located along the Mississippi and Ohio Rivers are automatically collected from USGS and RiverGages websites through APIs. Type of variables include: river stage, discharge, turbidity, water temperature, precipitation, relative humidity, and air temperature. Precipitation and relative humidity were not correlated to the variable to predict, and were removed from the pool. Only variables available for more than 90% of the historical period of record were considered. The remaining 39 variables are subject to replacement of erroneous values by linear interpolation, a minimum-maximum scaling, 7-day rolling averaging (in line with the data preparation of the variable to predict). Feature selection is completed through a decision-tree based gradient boosting regressor (XGB). The top-6 variables ranked by importance are used to feed the sediment forecasting regression model. This approach allows the framework to automatically adapt to potential future changes in data availability. Machine learning models learn repetitive patterns from relatively big data. To allow for a single historical time-series to be used for supervised machine learning, the 10 years of historical data are broken down into smaller time-series (i.e. "instances"). The size of the instances considers a number of days used by the model as input, or "in-lag", plus the 45-day prediction. For this work, models were applied and compared to the following scenarios of in-lags: 45; 60; 90; 120; 150, and 180 days. After removing the last 45-days used for model evaluation, for each scenario, as many as possible instances are created, each starting one day apart from each other. In this way, the machine learning regressor benefits from an increased number of instances to be trained and tested, without the need to generate synthetic data. For each regression model type (RF, MLP, and LSTM) several architectures and parameter set-ups were tested. The combination that produced the higher average nRMSE for each type of regressor was selected. The MLP regressor was constructed with two hidden layers of 10 and 5 nodes respectively, using hyperbolic tan activation function, and stochastic gradient descent for optimization of weights. The RF had 75 trees, and mean squared error was the loss function. To prevent overfitting, the maximum depth is limited to one layer, and the minimum number of samples required to split an internal node is two. The sequential LSTM was made with a dimensionality of 50-75 LSTM layers all with hyperbolic tan activation function. The final layer is a dense layer with a linear activation. During the training phase of each epoch, the model has dropout layers after each LSTM layer to prevent overfitting on the training data. For model evaluation purposes, in each in-lag scenario, the nRMSE is calculated over all evaluation instances. In addition, it is desirable to select a model with low variability of forecasted results. Thus, a confidence interval at 95% confidence level is calculated. Results indicate that all multivariate machine learning models outperformed the univariate baseline. Moreover, to evaluate future dredging needs, it is particularly interesting to observe the behavior of model predictions in the subset of instances with increasing shoaling trends. In this context, the lowest nRMSE was obtained with the MLP model for the 60-day input scenario. Acting as a digital twin of predicted SWP sediment volumes, the proposed model will modernize and accelerate dredging operations decision-making at SWP. The approach adopted for SWP in this work may be applied to forecast dredging needs at other critical waterways.

References: Dunkin, L. M., Coe, L. A., & Ratcliff, J. J. (2019). Corps Shoaling Analysis Tool : predicting channel shoaling. USACE-ERDC-CHL. doi:http://dx.doi.org/10.21079/11681/30382

Hartman, M. A., Mitchell, K. N., Dunkin, L. M., Lewis, J., Emery, B., Lenssen, N. F., & Copeland, R. (2022). Southwest Pass Sedimentation and Dredging Data Analysis. J. Waterway, Port, Coastal, Ocean Eng., 148(2).

Nel, H., Dalu, T., & Wasserman, R. (2018). Sinks and sources: Assessing microplastic abundance in river sediment and deposit feeders in an Austral temperate urban river system. Science of The Total Environment, 612, 950-956. doi:https://doi.org/10.1016/j.scitotenv.2017.08.298

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USGS. (2018, June 9). Sediment and Sustpended Sediment. Retrieved from Water Science School: https://www.usgs.gov/special-topics/water-science-school/science/sediment-and-suspended-sediment

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[9311] *Yearly Residential Electricity Forecasting Model based on Fuzzy Regression Time Series in Indonesia*

Riswan Efendi (UPSI).

Triangular fuzzy numbers (TFNs) are used to express the weights of criteria and alternatives to account for the ambiguity and uncertainty inherent to subjective evaluations. However, the proposed method can be easily extended to other fuzzy settings depending on the uncertainty facing managers and decision-makers. Triangular fuzzy number (TFN) is very important component to build fuzzy models such as fuzzy regression, fuzzy autoregressive and others. Many symmetrical triangular fuzzy numbers have been proposed in improving of scale's linguistic accuracy. While Sturges rule is also well-known approach for determining criteria or intervals. However, some existing TFN method are not easy to be followed and considered in building fuzzy regression models. The increasing of electricity distribution is caused by number of customer and amount of installed capacity factors in Indonesia. While both factors are uncertainty, inexactness, and random nature. In this paper, we investigated residential electricity model using fuzzy regression time series. In the beginning step, the integration between conventional TFN and Sturges rule is proposed in determining criteria or scale of linguistic terms. The secondary data was collected from BPS Indonesia from 2000 to 2021. The dependent variable was denoted as electric power distribution (Y_RT). On the other hand, number of customer and amount of installed capacity are grouped as independent variables (X_PL and X_KT). The results showed that the best forecasting model is a FLR right upper limit without constant. This proposed model also has high MAPE accuracy 1,44% if compared with classical models. Additionally, the proposed triangular fuzzy number was able to improve the accuracy of proposed model significantly. Interestingly, both dependent and independent factors are firstly forecasted using exponential smoothing model.

[9349] *Detection of instabilities in time dependent functional profiles*

Matus Maciak (Charles University, Prague) and Sebastiano Vitali (University of Bergamo).

We discuss a complex problem of recognizing and detecting stochastically relevant (significant) changes (changepoints) within in a time series of specific functional profiles -- the option market implied volatility (IV) smiles in particular. The main focus is on changes caused by various exogenous effects (meaning that the observed changes are not due the market itself but rather because of some human-made interactions).

The standard implied volatility tool (commonly used for the market analysis by practitioners) is shown to be insufficient for a proper detection and analysis of this type of risk. This is mainly becausethe exogenous changes are typically dominated by endogenous effects coming from a specific trading mechanism or a natural market dynamics.

We propose a unique methodological approach based on "artificial options" that always have a constant (over time) maturity. The key principle is to use interpolated volatilities that can effectively eliminate instabilities due to the natural market dynamics while the changes caused by the exogenous causes stay preserved. Formal statistical tests for detecting significant changepoints are proposed under different theoretical and practical scenarios.

Finally, important applicational issues are discussed, different scenarios are compared via a simulation study and real data examples are given for an illustration.

Maciak, M. and Vitali, S.(2023). Exogenous market changes analysis using artificial options volatility. Computational Economics Journal (resubmitted after revision)

[9354] *TROPOSPHERIC AND IONOFERIC MODELING USING GNSS TIME SERIES IN VOLCANIC ERUPTIONS (La Palma, 2021)*

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The signal coming from the artificial satellites of the GNSS system suffers various effects that considerably decrease the precision in solving the positioning problem. To mathematically model these effects, the atmosphere is divided into two main parts: the troposphere and the ionosphere. The troposphere can only be modelled; while the ionospheric effect can be modeled or eliminated depending on the geodetic sophistication of the receivers used. In this way, information is obtained about both layers of the atmosphere. For tropospheric modeling, the parameters of total zenithal delay (ZTD) or precipitable water vapor (PVW) will be taken, and for the ionosphere the total electron content (TEC) will be taken. In this work, statistical and analytical techniques will be applied with the R software; for example, ARMA, ARIMA models, least squares methods, wavelet functions, kalman techniques, and CATS analysis. With this, the anomalies that occurred in the values of the ZTD and TEC in the case of the 2021 eruption of the Cumbre Vieja volcano on the island of La Palma.

[9416] *Growth curves modelling and its application*

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In this article we compare two ways of modelling measures of fetal growth. The goal is to impute the missing information for certain ultrasound measurements that are observed at different times and with different numbers of observations. To analyze the effect that other variables have, such as environmental exposure to certain substances or diet, on fetal growth based on these data, we need to handle the information measured at the same instant of time for all the individuals under study, preferably in three time windows of pregnancy (first trimester, week 12; second trimester, week 20; third trimester, week 34). For this, data at these chosen times, in case they are not available, must be imputed from the available information using an appropriate statistical model. One option is to use a linear model, specifically a generalized least squares model is fitted to the features shown in the data. The other option is to use diffusion processes, estimating their parameters based on the available information. In both options, missing data can be estimated with the unconditional fitted model, conditional on the previous available measurement, or conditional to the closest measurement

[9419] *Multifractal organization of EEG signals in Multiple Sclerosis*

Marcin Wątorek (Cracow University of Technology; Theory of Complex Systems Department Jagiellonian University), Wojciech Tomczyk (Institute of Theoretical Physics, Jagiellonian University), Magda Gawłowska (Department of Cognitive Neuroscience and Neuroergonomics, Jagiellonian University), Jeremi Ochab (Institute of Theoretical Physics, Jagiellonian University) and Paweł Oświęcimka (Institute of Nuclear Physics Polish Academy of Sciences, PL-31342 Krakow, Poland).

In this contribution, multifractal analysis of the electroencephalography (EEG) data obtained from patients with multiple sclerosis was performed. The complexity of the EEG time series, quantified by scaling exponents, has been compared between the control group and patients. Particular attention has been paid to analysing the correlation between the degree of multifractality, disease duration, and level of disability. Our results reveal a significant correspondence between the complexity of the time series and multiple sclerosis development. Namely, for the specific brain regions, the well-developed multifractality and less persistence of the time series have been identified for patients with a higher level of disability, quantified by the Expanded Disability Status Scale (EDSS). Whereas the control group and patients with low-level EDSS were characterised by persistence and monofractality of the signals. The link between the multifractality and disease duration has not been observed, indicating that the multifractal organisation of the data is a hallmark of the disease development. Our conclusions are supported by the analysis of the cross-correlations between EEG signals. The most significant difference in the brain areas coupling has been identified for the cohort of patients with EDSS>1 and the combined group of patients with EDSS<=1 and the control group.

[9422] *Modeling of leishmaniasis infection dynamics: A comparative time series analysis with VAR, VECM, Generalized Linear and Markov Switching models*

Fadoua Badaoui (National Institute of Statistics and Applied Economics (INSEA), GEAS3D Laboratory.), Souad Bouhout (Direction of Epidemiology and Disease Control (DELM), Ministry of Health, Rabat.), Amine Amar (School of Science and Engineering, Al Akhawayn University in Ifrane.) and Kenza Khomsi (National Climate Center, Air Quality Department, General Directorate of Meteorology, Casablanca).

Despite new developments in disease control and advanced treatment methods, leishmaniasis is still one of the most prevalent tropical diseases in the world. The World Health Organization (WHO, 2023) defines Leishmaniasis as an infectious disease caused by Protozoan parasites in the genus Leishmania. The transmission of the disease occurs by the bite of a sandfly infected with Leishmania parasites. Infection may be restricted to the skin in cutaneous leishmaniasis (CL), the mucous membranes in mucosal leishmaniasis (MCL) or spread internally in visceral leishmaniasis (VL). This disease is in fact, a vector-borne disease of which the transmission is highly influenced by climatic factors, whereas the nature and magnitude differ between geographical regions. Further, it is known that spatial heterogeneity influences shifting the patterns of vector parasite interactions, vector-host contact and susceptibility of the population (Wijerathna, T., & Gunathilaka, N. (2022)).

Many recent studies and research (Medenica et al. (2023), Duarte et al. (2022) and Hakkour et al. (2020)) suggest that the incidence of Leishmaniasis is influenced by climatic variables. Therefore, prediction approaches developed are needed to achieve a better outcome in disease forecasting. In this context, the predictions through time series analysis are extremely important in the light of recent developments. This will undoubtedly help identify trends and possible disease outbreaks, which may ultimately facilitate a smooth and timely implementation of control programs through appropriate precautionary interventions (Huang et al. 2011). In this paper, we compare the performance of three statistical models, namely Vector auto-regressive (VAR) model, Vector Error Correction model (VECM) and Generalized Linear model (GLM) using different metrics. These models were selected based on a benchmarking study that show their usefulness to explain the dynamics in different fields. The prediction results of the developed models are compared to those obtained with Markov Switching model.

It is worth to note that Vector auto-regressive (VAR) integrated model, considered as an extension of the auto-regressive model, comprises multiple time series and is quite a useful tool for forecasting. However, time series models for VAR are usually based on applying VAR to stationary series with first differences to original series and therefore, this can usually present a loss of information about the relationship among integrated series. The usual alternative is to test a possible cointegration and to use VECM, which combines levels and differences.

The generalized linear model (GLM) is considered as a flexible generalization of ordinary linear regression, by allowing the linear model to be related to the response variable via a link function and the magnitude of the variance to be a function of its predicted value. The MSM, one of the most famous models for nonlinear time series, was used due to the problem of structural failure and nonlinearity of the series. The model is suitable for analyzing and predicting data with epidemic and non-epidemic states.

To implement our approach, recorded cases of leishmaniasis patients from different regions were provided by the Epidemiology Department from the ministry of Health in Morocco. This data was combined with the most notable climatic factor associated with leishmaniosis, namely the humidity, rainfall and the temperature, retrieved by assessing the open source records available on an international website. All statistical analyses were performed using R packages.

[9451] *Forecasting the Case Number of Infectious Diseases using Type-2 Fuzzy Logic for Diphtheria Case Study*

Wiwik Anggraeni (Institut Teknologi Sepuluh Nopember), Maria Firdausiah (Institut Teknologi Sepuluh Nopember) and Muhammad Ilham Perdana (Universitas Muhammadiyah Malang).

Diphtheria is an infectious disease with a high mortality rate. In Indonesia, the number of diphtheria cases is still relatively high in recent years, so ef-forts to prevent and control diphtheria are needed. Forecasting the number of diphtheria cases was carried out in this study by applying the type-2 fuzzy logic systems method. Forecasting in this study was carried out by involving the variables of the number of diphtheria sufferers, the percentage of im-munization coverage consisting of four types, and population density. Re-gions are grouped into three clusters based on the case number that have oc-curred. Each cluster is taken sampled in the form of one region to acquire a robust model for other regions. Forecasting results for the next 24 periods show that the performance of the type-2 fuzzy logic systems method is quite good with accuracy values in the Malang area showing MSE of 8,785 and SMAPE of 54.91%. In the Surabaya area the results of forecasting accuracy have an MSE value of 14,940 and SMAPE of 35.51%. In the Sumenep area, the results of forecasting accuracy show an MSE value of 2.188 and SMAPE of 67.63%. The results of forecasting the number of cases are expected to be a guide in planning and making decisions regarding the prevention and man-agement of diphtheria.

[9493] *Structure Determination for Sparse ARDL Models under High Dimensional Design Matrices*

Livio Fenga (University of Exeter).

Big Data matrices are becoming more and more a common place when secondary data are employed. By design, secondary data are not purposely collected for the intended research task and therefore often convey a limited amount of useful information. A common coping strategy for this situation is to include in the set of explanatory variables also those variables that can account for only a small portion (or even a fraction) of the total variations in the dependent variable. As a result of that, a big data design matrix is generated. However, in many instances, the exploitation of a dataset containing a great number of variables has many drawbacks, the most important one being associated with the extraction of only the relevant portion of the whole information set (usually a small subsample of the original dataset). Such a task becomes even more complicated in time domain, given the "physiological" inclusion in the design matrix of the lagged versions of all the available variables. But this is not the whole story. In fact, lag sparsity of the design matrix is very likely to happen in such a setup, which should always be considered. Accounting for sparsity in the vector of coefficients, however, almost surely increases the (already high) level of uncertainty surrounding the whole analysis.

The present paper aims at developing a method designed to enhance the variable selection procedure for Auto Regressive Distributed Lag (ARDL) models affected by high degrees of uncertainty induced by lack of parsimony in the original design matrix. Usually, ARDL models can efficiently accommodate a "small" number of independent lagged variable, how small depending on both the number of independent variables being investigated and the number of significant lags needed to be accounted for in the final model. The proposed dimension reduction procedure focuses on a model of the type of ARDL, which is envisioned to work in conjunction with a LASSO (Least Absolute Shrinkage and Selection Operator) method for the efficient suppression of the irrelevant information (that is the greatest part of the data matrix) not only by constraining the variables space but also the lag-space. While the former is based on a pure LASSO method, the latter relies on a novel criterion, which is aimed at discovering lag-consistency in the variables extracted by the LASSO procedure in the first place. The rationale is as follows: noisy and otherwise corrupted signals might generate many false relevant lags. Essentially, false positives are those lags which play no role in explaining the variability of the time series of interest and, if included in the final model, can generate many types of unwanted phenomena, e.g., degradation of the forecasting performances or noise. Especially with large data sets, it is vital to control for such a risk, and given the large number of time series involved, there are proportionally higher chances of selecting "bad" time series. To reduce the probability of inclusion of false positives in the final model, the envisioned lag-consistency detection procedure selects only the variables showing at least $k=1, 2,…,K$ significant coefficients (in the LASSO sense), k being arbitrarily selected, usually according to the number of variables resulting from the first round of selection. The theoretical justification of the method has been caried out using the multivariate t-distribution for dependent data. This distribution, which has a quite complex mathematical form, allows first the formalization of multiple dependent variances for multi-lag significant variables and secondly the theoretical proof of the validity of the proposed method. The studied procedure can be applied to carry out investigations on several complex phenomena, such as stock market or macroeconomic variables. A set of simulations have been carried out on the ISTAT (the Italian Office for National statistics) dataset comprising sentiment indicators for the different economic activities classified according to the NACE (Statistical classification of economic activities in the European Community) classification.

[9502] *Impact of migration processes on GDP*

Olena Rayevnyeva (Bratislava University of Economics and management), Kostyantyn Stryzhychenko (Simon Kuznets Kharkiv National University of Economics) and Silvia Matúšová (Bratislava University of Economics and management).

The globalization process and war in Ukraine show us that migration is one of the global trends in the modern economy. In the paper, we determined three types of migration depending on the quality of the people. There are labor, educational, and refugee migration. Each type has a different influence on the macroeconomic process. However, in this paper, we investigate the influence of general migration on GDP. We analyze five factors that have big influences on GDP, namely: migration (I), interest rate (IR), active population (AP), export (E), and consumer price index (CPI). For the purpose of this paper, vector autoregressive models (VAR model) were chosen. We used the Granger causality test to investigate the lag structure and identified exogenous variables in the VAR model, such as GDP, migration, and active population. We investigated the cross-influence between these factors, which shows that migration has a negative effect on the active population and a positive effect on GDP, and GDP growth leads to a decrease in migration. The Akaike and Schwartz criteria showed the high quality of the VAR models. The impulse analysis of shock influences gives the structure

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of the reaction of GDP and migration depending on their shock factors. By decomposition analysis, we found that migration and GDP influence each other by 10-14%, which can improve the forecasting of these factors and the study of structural migration by three types.

[9544] *Analysis of diversification in investment portfolios Return and Risk for different time horizons*

Marta Tolentino (Universidad de Castilla La Mancha), María del Valle Fernández (Universidad de Castilla La Mancha), Sergio Fanega (Universidad de Castilla La Mancha) and María de La O González (Universidad de Castilla-La Mancha).

The main objective of this paper is to analyse whether diversification in investment entails a reduction in risk and consequently in expected returns, according to the Modern Portfolio Theory (Markowitz, 1952). This is achieved through the construction of different investment portfolios with different levels of diversification, consist-ing of stocks from different sectors in the two most important Stock Markets in the world, the New York Stock Exchange and the Tokyo Stock Exchange, and cryptocur-rencies. For the division by sectors, we follow the proposed by Jareño et al, 2019, and the criterion used for the selection of stocks in each sector, as well as the two selected cryptocurrencies, Bitcoin and Ethereum, is that of the highest capitalisation value in the period analysed.

[9604] *Forecasting Industrial Production Using the State Dependent Models*

Saeed Heravi (Cardiff Business School) and Bo Guan (Cardiff Business school).

This study evaluates the forecasting performance of a general class of non-linear models called "State Dependent Models" SDM, which is developed by Priestley in (1908). Three different forecasting methods of state dependent models - the traditional recursive method, and two new forecasting methods involving a smoothed and an unsmoothed coefficient grid search methods were considered and employed in forecasting industrial production indices for the UK. Their forecast performances were then compared with ARIMA, Error Trend Seasonality (ETS) model and neural network autoregressive models in forecasting the eight industrial production series of seasonally unadjusted industrial production indices for the United Kingdom. The results show the dominance of the three SDM models compared to other three methods. Improvement in Root Mean Squared Error (RMSE) is more pronounced in the long-run forecasting.

[9606] *Modeling of the Dynamic Impacts of the Financial Market, Economic and Trade Policy Uncertainties on Import Demand*

Miao Miao (Chengdu Normal University), Jiang Yushi (Southwest Jiaotong University) and Dinkneh Gebre Borojo (Southwest Jiaotong University).

This study is aimed to investigate the short and long-run dynamic heterogeneous impacts of economic policy uncertainty, trade policy uncertainty, and financial market uncertainties on import demand forecasting. It utilizes the Pooled mean group autoregressive distributed lag (PMG/ARDL) estimator for the panel of 38 countries using quarterly data from 1996Q1 to 2020Q4. For the robustness test, the asymptotic distribution of the Cross-section augmented distributed lag (CS-DL) is used to control for cross-sectional dependence concerns. The study's findings imply that domestic and global economic and trade policy uncertainties have significant adverse long and short-run impacts on import demand. Therefore, it calls for timely investigations of the causes of policy uncertainties (domestic or global) and to take effective counter policies to address uncertainties. Besides, global economic shocks easily transmit to countries; thus, it needs collective policy actions

[9608] *A review of the potentialities of statistical and mathematical approaches*

Sergio Gallego-García (UNED).

The paper deals with the new capabilities and challenges of statistical and mathematical approaches. To do this, first, the development of how these capabilities have been developed and what is the current state of the art will be presented. Then, the different approaches providing methodologies to them will be presented. Afterwards, it will be presented an assessment of how these capabilities will change the management and control of organizations. Finally, application cases

will be presented in which the potentialities are identified as an opportunity for greater knowledge leading to innovations and improvements in different kinds of organizations and in society.

[9618] *Forecasting and Explaining Infant and Youth Mortality in Portugal*

Joao Sousa (IDMEC, Instituto Superior Técnico, Universidade de Lisboa).

In order to achieve a more efficient allocation of healthcare resources in the near future it is crucial to understand the patterns and causes of excess mortality and hospitalizations. Concretely, infant and youth mortality still pose a significant challenge, particularly in developed nations where the mortality rates are already low and healthcare resources are generally available to most of the population. Furthermore, the low mortality rates also mean that the data available for modelling is often very limited, restricting the modelling methods that can be used. It is also important that the chosen methods allow for explainable, non black box models that can be interpreted by healthcare professionals. Attending to these challenges, the work hereby presented thoroughly analyzes the time series of the infant and youth mortality rates in Portugal between 2014 and 2019 in terms of trend and seasonal patterns, and also the applicability and performance of different data based methods. Furthermore, the mortality rates are also studied in terms of their relation to environmental variables, such as temperature and air pollution indicators, with the goal of establishing causal relations between such variables and excess mortality. The preliminary results show that ARMA, NARX, Takagi-Sugeno-Kang (TSK) and ALMMo fuzzy inference systems are able to forecast the studied mortality rates with acceptable degrees of accuracy. Furthermore, fuzzy inference systems are shown to be particularly well suited to the aforementioned requirement of obtaining explainable models while still achieving acceptable degrees of accuracy. It is also shown that ALMMo fuzzy models are able to achieve a comparable performance to TSK fuzzy models, while remaining computationally lightweight.

[9648] *Competition in the Slovak Mobile Telephony Industry: Effects of new entry*

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The last decades have seen increasing competition in telecommunications markets. Markets with a single monopoly, often state-owned, provider (incumbent) of telecommunications services have turned into a competitive market with many players. Liberalisation and privatisation have stimulated competition in these markets, together with the advent of new technologies such as fibre optics in fixed networks, or 5G technologies in mobile networks, and entirely new services have been introduced in the sector. These technological advances have reduced retail prices in particular for end consumers, who have a choice between a wide range of products and services. Telecommunication regulators have successfully opened up markets and helped to promote competition, especially at the service level. However, not all markets are or can be fully competitive. The market for mobile services may be one such market. Not necessarily, where competition is allowed, meaningful and developed competition with a competitive environment is also present. One such reason may be the presence of a scarce natural resource - the radio spectrum available for mobile telecommunications services. This creates a natural barrier to entry for new players. Therefore, the network industries markets can see regulation to ensure the efficient functioning of this network infrastructure. Many empirical and theoretical studies of mobile markets (e.g. Dörrenbächer (2000); Curwen and Whalley (2006) or Grzybowski (2008)) have already shown that the market concentration is an important indicator of the intensity of competition in a given market. This market concentration can then have an impact on the quality of service provided to end customers. The first studies in the 1990s focusing on the market concentration in the mobile services market mainly analysed the state of competition in duopolistic market structures in the United States, the United Kingdom and Sweden. Parker and Röller (1997) analysed the US mobile market and competition between two mobile service providers and they conclude that prices for mobile services at that time were well above competitive levels, and even above those of the non-cooperative duopoly. Busse (2000) examined tacit collusion between two mobile service providers in the US market and concludes that this collusion may have increased prices to end customers. Fullerton (1998) reaches similar conclusions, examining the 28 US states where mobile services were first provided and concludes that the intensity of competition itself varied considerably, although almost all markets experienced price declines, he finds considerable variation in the performance of individual markets between states. Stoetzer and Tewes (1996) find similar findings of stable and high prices based on tacit collusion for end-customers in duopoly markets in the German mobile market and Valletti and Cave (1998) in the UK market. Whalley and Curwen (2012) analyse the market shares of mobile service providers in 49 European countries. They conclude that in most European countries the incumbent remains the largest operator. These authors conclude that many European markets were highly concentrated in 2010, which was a major barrier to entry for new players. Furthermore, for example, Andini (2011) examined EBITDA across 177 mobile operators in 45 countries and found that the market power effect is dominated by efficiency over the period 1991-2004. Sung (2014) examines mobile market

concentration over the period 1998-2011 in OECD countries and he finds a positive relationship between market concentration, prices and profits. Recently, market consolidation can be noticed in many mobile service markets due to mergers and acquisitions, which have been the focus of research (Pedrós et al., 2017; Aguzzoni et al., 2018; BEREC, 2018; Aimene et al., 2021). On the other hand, there are rare entries of new players in the mobile market. For example, Gagnepain and Pereira (2007) examine the Portuguese mobile market after a third operator entered it in 1998. They note significant cost reductions and increased competition in this market. This study builds on these works by examining the impact of the entry of a fourth mobile network operator (4ka) in the Slovak mobile market on October 5, 2015, using quarterly data for the years 2010 to 2020. The difference in differences method, which is standardly used in ex-post evaluation of policy implementation and has recently found application in industrial organization research, especially for mergers and acquisitions (e.g. Focarelli and Panetta (2003); Ashenfelter et al. (2013)) was used. This method compares changes in the treatment group against a control group, which here represents other European Union countries where there has been no new entry or market exit. For robustness of the results, the Synthetic control method was also used together with the placebo test proposed by Abadie et al. (2010, 2015). With the merger evaluation, Hosken et al. (2018) used the same approach together with the standard Difference in differences analysis. The study focuses on 3 main market outcomes - ARPU (average revenue per user), price of mobile telecommunication services and mobile traffic. The results of this study show that the entry of a new operator had the effect of reducing ARPU, so that customers on average pay less for mobile telecommunication services, with higher consumption of mobile services. Total ARPU decreased by between 3.6% and 11.7%. This was driven by a reduction in ARPU for voice services of 15% and ARPU for data services of up to 25% in the first year after the entry of a new operator. As regards the change in traffic after the entry of the new operator, voice traffic increased by between 3 and 8.7% in the first two years, as did SMS traffic, which increased by up to 34%. As for data services, the new entry had no significant effect on price of 1 MB and data traffic. On average, the price per minute of calls decreased by 10%. The results therefore suggest that the increase in competition in the mobile market by entry of new mobile network operator has had a positive effect on consumers in terms of reducing prices for mobile services and increasing their consumption of tradition telecommunication services but not data services. Which is in line with recent research (Aimene et al., 2021) showing that not the growth of market players but mergers may have a more sensitive impact on falling data prices rather than rising voice prices.

[9671] *Multi-Output Variational Gaussian Process for Daily Forecasting of Hydrological Resources*

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Water resource forecasting plays a crucial role in managing hydrological reservoirs, supporting operational decisions ranging from economic to energy. In recent years, machine learning-based models, including sequential models such as Long Short-Term Memory (LSTM) networks, have been widely employed to address this task. Despite the significant interest in forecasting hydrological series, weather's nonlinear and stochastic nature hamper the development of accurate prediction models. This work proposes a Variational Gaussian Process-based forecasting methodology for multiple outputs, termed MOVGP, that provides a probabilistic framework capturing the prediction uncertainty. The case study focuses on the Useful Volume and the Streamflow Contributions from 23 reservoirs in Colombia. The results demonstrate that MOVGP models outperform classical LSTM and linear models in predicting several horizons, with the added advantage of offering a predictive distribution.

[9674] *The Dutch Disease in Angola: An Empirical Analysis*

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Despite being the second largest oil exporter in Africa, Angola continues to lag behind in most macroeconomic and institutional indicators. At least partially, this is a consequence of the Dutch disease, a phenomenon that establishes a clear link between high resource endowments and the lack of economic diversity through the loss of international competitiveness in the non-resource sectors. In this paper, we use a nonlinear autoregressive distributed lag (NARDL) model to identify the cointegrating relationship between the international oil prices and the real effective exchange rate of the kwanza, which is a striking sign of the presence of the Dutch disease.

[9691] *Treatment and analysis of multiparametric time series from a seismogeodetic system for monitoring tectonic activity in the Gulf of Cádiz.*

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The tectonic activity produced by the interaction of the Eurasian and African plates continually generates high seismic activity and the possibility of tsunamis occurring in the Gulf of Cádiz. The occurrence of these phenomena and the associated hazard implies the need to implement a prototype seismogeodetic system (formed by seismic, accelerometric, inclinometric, and meteorological sensors), which generates a set of data that allows monitoring of tectonic activity in the Gulf and areas adjacent. This prototype generates GNSS, seismic, accelerometric, and meteorological time series in real and deferred time, which, together with the implementation of geodetic and geophysical techniques, is capable of providing information on tectonic activity immediately; in order to know and evaluate the possible associated dangerous geological phenomena. The advantage of this prototype lies in the correlation of the different time series and the results obtained; as well as its ability to integrate with a regional early warning system (EWS) that allows to communities or organizations that live in areas threatened by natural hazards to make appropriate decisions in the event of such phenomena.

[9729] *Update of the strain rates of the Galera and Baza faults from GPS position time series in the period 2009 - 2020*

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The Baza and Galera faults are two active geological structures placed in the central zone of the Betic Cordillera (Southern Spain). The Betic Cordillera is located in the western part of the Peri-Mediterranean Alpine Orogen. At present, it is undergoing to an NNW-SSE main shortening and, in its central sector, an approximately perpendicular extension along the ENE-WSW to NE-SW direction. The extension is mainly accommodated by NNW-SSE normal faults. This extension deforms the materials belonging to the Internal and External zones of the mountain range, as well as the sedimentary infill of intramountain basins, including the Guadix-Baza Basin. The Baza Fault is a normal fault 40 km long, with a direction that varies from NW-SE to NS and a dip that ranges between 45° and 65° towards the ENE. The Galera Fault is a 25 km-long strike-slip fault striking N065E. In 2008 a GPS survey–mode network of seven sites was built to monitor these faults. These sites are located in well-defined areas in the two geological blocks of the faults. They are perfectly fixed over the surface on exposed rocks using self-centering mounting. Here we show the new results computed from 10 GPS campaigns in the timespan 2009-2020. The measurements have been done in September 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018, and 2020. In the 2009 and 2010 campaigns, the GPS receivers used were Leica Geosystem GX1230 receivers and LEIAX1202 antennas whereas in subsequent campaigns 2011, 2012, 2013, 2014, 2015, 2017, 2018, and 2020 the sites were observed with LEICA Geosystem AR10 receivers and LEIAR10 antennas. The data processing was performed by Precise Point Positioning using GipsyX software. GipsyX is a GNSS-inferred positioning software developed by the Jet Propulsion Laboratory (JPL) and maintained by the Near Earth Tracking Applications and Systems groups. Then, the new estimation of the slip rates is computed from the GPS time series by SARI software. The model applied to the original time series, using weighted least squares, consists of an intercept, a site rate, and an offset to account for antenna change. The error term is composed of white noise and temporally correlated random error. The colored noise is

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described by a random-walk process. We have assumed a typical magnitude for this process of 1.0 mm/vyr. Finally, we discuss the implications of the new results for the tectonic setting and seismic hazard assessment of this key tectonic area of the Betic Cordillera.

[9731] *The impact of national minimum wage policy on inflation and unemployment in South Africa: A segmented regression analysis*

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This study is an empirical contribution to the debate on the response of inflation and unemployment to the implementation of the national minimum wage policy in South Africa. Using segmented regression analysis for the period (2015-2022), the study finds that the national minimum wage policy significantly exacerbated inflation and unemployment rates in the country. Furthermore, the impact was more severe on inflation than on unemployment. These findings suggest that the NMW policy implementation caused more harm than good to the low-income earners and the unskilled unemployed population, who continue to disproportionately suffer from inflation and limited employment opportunities, respectively.

[9798] *Modeling contagion of financial markets: A GARCH-EVT Copula approach*

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Financial resilience in banking is considered as a key pillar, when discussing the strength of the international financial system and the world economy as a whole. Indeed, financial resilience becomes the more puzzling and worrying in the context of the increasingly frequent, significant and complex events. These extreme events include the stock market crash of 1929, the stock market crash of 1987, the sudden devaluation of the Mexican peso against the U.S dollar in December 1994, the 1997 Asian financial crisis, the global financial crisis between mid 2007 and early 2009. All these crashes are characterized by a subsequent rapid spread, significant severe losses incurred by financial institutions, spillovers and a high contagion risks. These events revealed in fact substantial weaknesses in the banking system and the prudential framework and thus, motivated many of the managers and researchers, to recover existing tools and to implement new management tools that offer significant improvement, by taking into consideration the increased severity, the high frequency of extreme events and spillover effects. One important suggestion is to reconsider the Value-at-Risk (VaR); the widely used risk management tool, in the context of the extreme events and contagion effects, which are nonlinear, time varying and dependent in nature. The VaR can be defined as the maximum potential change in value of a portfolio of financial instruments with a given probability over a certain horizon. There are several approaches for the estimation of VaR, such as historical simulation, the variance-covariance and the Monte Carlo approaches. In addition, , contagion can be empirically identified through the propagation of extreme negative returns, the increase in interdependence compared to normal times, and the distinction from common shocks (ECB, Financial Stability Review, 2005). The literature contains various definitions of financial contagion (Davidson, 2020). However, financial contagion is present if a statistically significant increase is observed in cross-market correlation after the occurrence of extreme shocks (Forbes and Rigobon, 2002). To better assess the financial contagion through the VaR, several recent studies used copula models to describe the multivariate dependence structure between financial markets, to estimate the return period and to assess the corresponding losses. In the same context, this paper addresses the inefficiency of the classical approach like a normal distribution in modeling the tail risk, by using the conditional Extreme Value Theory (GARCH-EVT), in order to assess extreme risks with contagion effect. The GARCH-EVT approach is a two-stage hybrid method that combines a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) filter with the Extreme Value Theory (EVT). The Peaks-Over-Threshold approach will be used for the pre-specification of the threshold that separates distribution tails from its middle part. To implement our approach, we use time series retrieved by assessing the open source records available on an international website. All statistical analyses were performed using R packages and our results provide important insights on risk management.

[9913] *Application of machine learning in modeling the relationship between catchment attributes and in-stream water quality*

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In order to be able to manage water quality, it is necessary to determine the relationship between the physical attributes of the catchment, such as geological permeability and hydrologic soil groups, and instream water quality parameters. The paper gives relations for 11 in-stream water quality parameters K^+, Na^+, Mg^{2+}, Ca^{2+}, SO_4^{2-}, Cl^-, HCO_3^-, SAR, pH, EC, and TDS using machine learning methods. For each parameter, RMSE, MAE, R, and MAPE accuracy criteria were used to assess the accuracy of each model, and the optimal model was defined. Furthermore, the most significant influencing variables were determined when modeling each parameter. Research has shown that with methods based on artificial intelligence, a quick and sufficiently accurate water quality assessment is possible, depending on the attributes of the watershed.