

PLENARY LECTURES

EFFICIENT AND CONSISTENT DATA-DRIVEN MODEL SELECTION FOR TIME SERIES

Jean Marc Bardet

SAMM, Université Paris1.France

This paper studies the problem of model selection in a large class of causal time series models that includes ARMA or AR(∞) processes as well as GARCH or ARCH(∞), APARCH, ARMA-GARCH - and many other processes. First, we study the asymptotic behavior of the ideal penalty that minimizes the risk defined from a quasi-likelihood estimation among a finite family of models containing the true model. We then establish general conditions on the penalty term to obtain properties of consistency and efficiency. In particular, we prove that consistent model selection criteria outperform the classical AIC criterion in terms of efficiency. Finally, we derive the usual BIC criterion from a Bayesian approach and, retaining all second-order terms of the Laplace approximation, a data-driven criterion, which we call KC'. Monte Carlo experiments illustrate the asymptotic results obtained and show that the KC' criterion performs better than the AIC and BIC criteria in terms of consistency and efficiency.

SO YOU WANT TO DESIGN AND LAUNCH AN MS PROGRAM IN ANALYTICS?

James Cochran

University of Alabama, USA

In this talk, we consider the steps an academic unit might consider when designing and launching a Master of Science program in Analytics. We will use the speaker's experience in establishing the Master of Science program in Analytics for The University of Alabama's Culverhouse College of Business. Topics covers will include i) understanding your resources, ii) designing the program, iii) getting approval and implementing, iv) growing the program and v) lessons learned. We will also discuss false starts and mistakes we experiences (and perhaps how to avoid them as you design a Master of Science program in Analytics for your institution).

EARLY STOPPING FOR GRADIENT DESCENT

Alain Celisse

Centre PMF, Laboratory SAMM, Université Paris1, France

The purpose of the present talk is to describe a general strategy (called early stopping) for choosing the number of steps to perform with a gradient descent-like algorithm. The analysis we develop is made within the RKHS corresponding to a reproducing kernel. We identify two scenarios for which we get optimal results in terms of minimax rates. The key ingredient in our strategy is the so-called Minimum Discrepancy principle. We prove that a slight modification of this principle leads to improved performances. All along the talk, we use simulated data to illustrate the practical behavior of our approach

SEGREGATION THROUGH THE MULTISCALAR LENS

Madalina Olteanu^{*}, W. Clark^{**}, C. de Bézenac^{***}, and J. Randon-Furling^{**}.

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In this talk, we present some recent results which aim at tackling the issue of residential segregation from a multiscalar point of view. They build upon a new mathematical framework which allows one to carry multiscalar spatial exploratory analysis across urban regions. After defining the notions of trajectory, focal distance, and distortion coefficient, we illustrate them on several data sets focusing on ethnic mixing in Los Angeles, Chicago, and Paris. We will show how this framework provides a practical and powerful tool for the comparative study of urban segregation. The present talk represents joint work with

OPTIMIZATION PROBLEM WITH VARIABLE DOMINATION STRUCTURES: PRINCIPLES AND APPLICATIONS

Christianne Tammer:

Martin-Luther-University Halle-Wittenberg, Germany

In this talk, we are dealing with vector optimization problems in infinite-dimensional spaces where the solution concept is given by variable domination structures. Vector optimization with variable domination structures is a growing up and expanding field of applied mathematics that deals with optimization problems where the domination structure is given by a set-valued map. Interesting and important applications of vector optimization with variable domination structure arise in economics, behavioral sciences, in portfolio management, locational analysis and radiotherapy treatment in medicine. We introduce several concepts for solutions to vector optimization problems with variable domination structures and show corresponding characterizations by means of nonlinear functionals. Furthermore, we derive duality assertions, existence results of Takahashi's type and necessary conditions for approximate solutions using techniques from variational analysis. These results are useful for further research on the field of vector optimization with variable domination structure, especially, for deriving numerical procedures.

TUTORIALS

VARIATIONAL ANALYSIS IN OPTIMIZATION AND CONTROL

Boris Mordukhovich

Wayne State University, Detroit, Michigan, USA

June 1st-2nd, 10:20-12:00 (2h lecture part).

The tutorial consists of two lectures, which present recent applications of variational analysis to numerical optimization and optimal control.

LECTION 1: Globally convergent coderivative-based Newtonian algorithms in nonsmooth optimization. This lecture is devoted to applications of second-order variational analysis and generalized differentiation to the design and justification of novel generalized Newtonian algorithms. We present coderivative-based versions of the damped Newton method and of the Levenberg-Marquardt method designed via the generalized Hessian. Efficient conditions for the global convergence of these algorithms are obtained for problems of convex composite optimization with establishing their superlinear convergence rates and applications to Lasso problems.

LECTION 2: Optimal control of sweeping processes with applications to robotics and traffic equilibria. This lecture is devoted to applications of variational analysis to a new and challenging class of optimal control problems for sweeping (Moreau) processes, which are governed by discontinuous differential inclusions and have numerous applications to mechanics, economics, etc. We develop the method of finite-difference/discrete approximations to the study of such problems and then derive in this way necessary optimality conditions for discrete-time and continuous-time systems with their applications to some models of robotics and traffic equilibria.

A SHORT INTRODUCTION TO WAVELET METHODS IN STATISTICS

Fabien Navarro

SAMM, Paris I, Université Paris I, Francia.

May 31th, 9:30-12:30 (2h lecture part and 1h computer practice session).

Starting from classical notions of shrinkage and sparsity, this short course will cover selected topics of regularization and thresholding methods that are crucial to high dimensional statistics. The syllabus includes some aspects of feature selection and model selection, linear and nonlinear techniques for wavelet regression. The course will mainly focus on methodological aspects. A short practical session will provide an opportunity to apply the methods using R.

EVALUATION OF KI-67 INDEX WITH DEEP LEARNING

Joseph Rynkiewicz

SAMM, Paris I, Université Paris I, Francia

May 31st, 16:00-17:30.(2h lecture).

The value of the Ki-67 index was introduced as a proliferative marker by Gerdes et al. in 1983. Monoclonal antibody Ki-67 is present during reproducing cell cycle phases. Knowing that excessive cellular proliferation correlates with the progression of malignancy, precise estimation of this protein marker can benefit physicians in identifying high-grade tumors. The method for Ki-67 detection is Immunohistochemical analysis in the staining process performed on paraffin-embedded tissue. Marker scoring is based on an expert pathologist's decision, and inter-observer result variations are inevitable. Moreover, at least 500-1000 cells in a representative area are recommended to be counted by the pathologist, which can be very time-consuming. This prompted the need for an exact calculation of the Ki-67 marker using Artificial intelligence. This tutorial will demonstrate a method to get state-of-the-art results with Deep networks.

MAIN LECTURERS

EFFICIENT PUBLIC TRANSPORT SERVICES TO IMPROVE LIVING CONDITION IN RURAL AREAS

Joachim R. Daduna

Berlin School of Economics and Law, Germany

Since the beginning of industrialization, living conditions in urban and rural areas have drifted more and more into different directions over many years. This almost everywhere existing situation is politically undesirable for many reasons, so that there are increasing efforts to equalize living conditions. The focus here is on ensuring sufficient mobility as the basis for better social and economic participation of the population in rural areas. An essential step in this respect can be the use of autonomously driven vehicles within the framework of demand-oriented and flexible public transport services. With the use of mini and midi-buses, it is possible to ensure a quasi-individual mobility with a 24/7 service period for all residents in rural areas. This can provide access to different supply facilities as well as to a wide range of commercial and public services. The necessary technical preconditions are available, so that a broadly focused realization will be possible in the near future. To implement such solutions, appropriate concepts must be developed and their introduction into regular operation must be enforced, also with a view to increasing traffic safety as well as against objectively unfounded doubts.

Keywords: Autonomous vehicles, Public transport, Rural areas, Equal living conditions

BEYOND CRYPTO-CURRENCIES. BLOCKCHAIN, THE TRUST MACHINE

Miguel Katrib Mora

Universidad de La Habana, Cuba.

With the launch of bitcoin, a new architecture of trust emerged in the world: blockchain. This talk presents the fundamental pieces of blockchain technology that inspire this trust: decentralization of control for greater democracy in the network, representation of transaction data in a ledger database that is replicated across all nodes, application of cryptography for security, veracity and inalterability of data, open source code, consensus protocols for collective acceptance of the correctness of transactions, smart contracts as an execution logic stored by the blockchain itself facilitating the versatility of applications by expanding the concept of value beyond money.

A FEDERATING SPARSE APPROACH FOR GRAPH AND WORD EMBEDDING WITH HIGH EXPLAINABILITY CAPACITIES

Jean-Charles Lamirel

LORIA – University of Strasbourg, SAMM, University of Dalian

While graph embedding aims at learning low-dimensional representations of nodes that encompass the graph topology, word embedding focuses on learning vectors of words that encode semantic properties of the vocabulary. The former finds application in tasks such as link prediction and node classification, while the latter is routinely used in natural language processing. Most of the time, graph and word encodings are considered as independent tasks. However, word co-occurrence matrices, which are often used to extract embedded words, can be considered as graphs. In addition, most network embedding techniques are based on either a word embedding method (Word2vec) or matrix factorisation, which is also often used for word embedding. These methods are generally computationally time consuming, parameter dependent and the dimensions of the embedding space are not interpretable. To circumvent

these problems, we introduce the Lower Dimension Bipartite Graphs Framework, which exploits the fact that all graphs can be described as bipartite graphs, even in the case of textual data. This underlying two-level structure can be explicit, as in the case of co-author networks. With our approach, however, we focus on revealing latent bipartite structures, as they appear for instance in social or word co-occurrence networks, and in particular on those structures that provide more concise and interpretable representations of the existing graph. In addition, we propose an efficient implementation of our approach, which extracts sparse and interpretable node representations, using the community structure to approximate the underlying bipartite structure. In the case of graph integration, our temporal near-linear method is the fastest in our benchmark, is parameter-free and provides state-of-the-art results for classical link prediction. In the case of word embedding, our approach proves to be very efficient in terms of classical similarity evaluation.

Keywords: Polysomnography, Sleep Stage Scoring, Digital Signal Processing, Machine Learning

SMART CONTRACTS AND TOKENIZATION IN BLOCKCHAIN.THEIR POTENTIAL FOR INNOVATION IN TRACEABILITY APPLICATION.

Alexi Massó Muñoz

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The so-called “Blockchain 2.0” started with the Ethereum blockchain. A really big change for the cryptocurrency use case came with Buterin's contribution. Then the concept of smart contract arises.

Today, several years later, we can see a growth in the creation of dapps in other areas than cryptocurrencies. A special use case that has a performance boost with the use of blockchain and smart contracts is traceability systems.

The supply chain in the pharmaceutical business, the production of fuel and goods, and the transportation of products are today based on blockchain. About these applications and the possible future of Traceability Systems on blockchain will be discussed.

CONTRIBUTIONS

A MULTI-OBJECTIVE EVOLUTIONARY ALGORITHM FOR EEG INVERSE PROBLEM.

José Enrique Alvarez-Iglesias, Mayrim Vega-Hernandez, Eduardo Martínez-Montes
Neuroinformatics Department, Cuban Neuroscience Center, Havana, Cuba

In this paper, we proposed a multi-objective approach for the EEG Inverse Problem. This formulation does not need unknown parameters that involve empirical procedures. Due to the combinatorial characteristics of the problem, this alternative included evolutionary strategy to resolve it. The result was a Multi-objective Evolutionary Algorithm based on Anatomical Restrictions (MOEAAR) to estimate distributed solutions. The comparative tests were between this approach and 3 classic methods of regularization: LASSO, Ridge-L and ENET-L. In the experimental phase, regression models were selected to obtain sparse and distributed solutions. The analysis involved simulated data with different signal-to-noise ratio. The indicators for quality control were Localization Error, Spatial Resolution and Visibility normalized. The MOEAAR evidenced better stability than the classic methods in the reconstruction and localization of the maximum activation. The norm L0 was used to estimate sparse solutions with the evolutionary approach and its results were relevant.

Keywords: multiobjective, evolutionary, inverse problem, EEG, algorithm.

IMPLEMENTATION OF A HERMITEINTERPOLATION SCHEME BASED ON ELASTICQUADRATIC A-SPLINE CURVES

Loidel Barrera Rodríguez
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The minimization of an energy functional is the main ingredient of several segmentation and modelling problems. When the solution of this kind of optimization problem is described by a curve, the most popular approach consists in representing the curve as a parametric curve and to compute the minimum in terms of the free parameters of the curve. In free form design tasks, the fairness (energy) functional depends of the arc length and the bending energy of the curve and the classical approach requires to compute first and second derivatives. This work presents an implementation and operation of a linear subdivision scheme, based on Bezier rational curves with local tension parameters. Also it shows a software implementation of an algorithm for energy minimization of the functional. The curve that minimizes the functional is called the fair curve, and it shows excellent properties to be used for design purposes. The novelty of the proposed method lies in the fact it is derivative free. Also the paper brings a discussion of the implementation of our method and show some numerical results.

Keywords: Fairness, interpolation, subdivision scheme, optimization, numerical methods.

PROCEDURES FOR SCRAMBLING SENSITIVE QUANTITATIVE VARIABLES: AN UPDATED REVIEW

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When sampling by survey, the main objective of the researcher is to know some characteristic of interest of a population. The aspiration of the sampler is that all the respondents in the sample answer the

question of interest, but this hardly happens in reality. This lack of response is known as sampling errors. Such errors are caused, for example, by non-response or a false answer that is usually related to a sensitive question that respondents refuse to answer. To solve the above problem, Warner (1965) proposes a methodology which is mainly based on obtaining information about a sensitive characteristic Y without giving know this information directly, that is, keeping the confidentiality of the respondent. In this document is presented a review of the current literature on randomized responses for quantitative variables. The review is chronological ordered considering its origin, Warner (1965), going through the first quantitative RR works as Greenberg et al. (1971), Eriksson (1973) and the first quantitative RR technique that scrambling the sensitive value with a device, Eichhorn and Hayre (1983), up to recent proposals. For a better study, the techniques are classified in compulsory randomized responses techniques (CRRR), full optional randomized responses techniques (FORRT) and partial optional randomized responses techniques (PORRT), and some are selected for their evaluation. The study interest on RR techniques is to know the characteristics of the sensitive variable Y as $\hat{\mu}_Y$, $V(\hat{\mu}_Y)$ and $\hat{V}(\hat{\mu}_Y)$. A study using real data is developed using data that may be considered as sensitive, evaluating the accuracy and efficiency of the best quantitative RR techniques.

Keywords: randomized responses, scrambling, simple random sampling, sensitivity level.

CONVEX COMBINATION GENERATED BY APPLICATION OF TWO WERNER RANDOM RESPONSE PROCEDURES

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In many questionnaires there are some questions that reveal information that may cause stigmatization of the individuals. To get true information, Randomized Responses (RR) can be used. In this work, this approach is generalized by carrying out an interview scheme in two stages. This procedure results in a convex formulation of this technique. An estimator of the proportion of individuals with the stigma in the sample is found.

Keywords: Direct responses, bias, expectation, probability, non-sampling error.

STEEPEST DESCENT METHODS FOR DIFFERENT CLASS OF OPTIMIZATION PROBLEMS: AN OVERVIEW

Gemayqzel Bouza Allende

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Steepest descent methods are a classical method for solving optimization problems. This approach is based on, given a point, finding a direction where better solutions can be found and choosing for the next iteration a point on this ray with better evaluation of the objective function without too much computational effort. In this paper we present how this approach has been adapted to different classes of problems, such as vector optimization with variable ordering and set a special class of set valued optimization problems. Convergence results will be shown.

Keywords: convergence, set valued optimization problems, steepest descent methods, variable ordering, vector optimization problems

EXTENSION OF THE FLOW-BASED CAPACITY CALCULATION AREA OF THE EUROPEAN ELECTRICITY TRANSMISSION NETWORKS.

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**French transmission system operator Réseau de Transport d'Electricité (RTE), France

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Within the framework of calculations related to network management, RTE has developed a set of algorithms to calculate, visualize and optimize the network's stability domains for

interconnections between France and various European countries. One of the calculation processes consists in measuring the differences between two stability domains, which are represented by convex polyhedra linked to the forecasts of net positions of the different countries studied. This approach, called flow-based, allows to calculate cross-border exchange capacities for electricity exchanges. Its role is to provide the electrical market with hourly sets of possible exchanges which ensure that the physical limitations of the grid are respected. It has been applied in the Central Western Europe (CWE) area since 2015. Market developments, now oblige network operators to think in CWE mesh in 5 distinct zones. In the long term, operators would like to be able to study trade over the entire CORE area, which includes 11 European countries. To overcome the computational challenge associated with this increase in dimension, we propose a new measure of distance between stability domains. We then develop some optimization algorithms to minimize this distance. Finally, the proposed methodology is illustrated by numerical simulations.

CHARACTERIZATION OF THE ECONOMIC VARIABLES OF BARLEY PRODUCTION TECHNOLOGIES IN MEXICO

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**Universidad Juárez Autónoma de Tabasco, México.

Barley is a cereal that provides raw material for the agro-industry of beer and for livestock feed, basically. Likewise, barley by production volume is the fourth cereal worldwide, after corn, wheat and rice. The main cereals produced in Mexico, by production volume, are corn (85.6%), wheat (10.2%), barley (3.0%), rice (0.8%) and oats (0.3%). The research aimed to characterize the economic variables of barley production technologies in Mexico, with the application of proportions and growth rates. Based on the type of humidity, the rain-fed and irrigation production technologies were identified and characterized. The rain-fed harvested surface is greater than the irrigated harvested surface and the rain-fed surface provides a volume of production greater than the production generated by the irrigated surface. The growth rates of the harvested area are mainly explained by the growth rates of the rain-fed area harvested and the growth rates of production are basically explained by the growth rates of irrigation production. The loss indices obtained, by relating the harvested surface to the sown surface, are higher on rain-fed surfaces and lower on irrigated surfaces, which tend to zero. Finally, the growth rates of the economic variables of barley production were positive, reflecting profitability and expansion of the crop.

Keywords: harvested area, yields, growth rate.

AUTOREGRESSIVE ECONOMETRIC MODELING (AR) OF GROSS FIXED CAPITAL FORMATION AND FOREIGN DIRECT INVESTMENT IN THE ECUADORIAN ECONOMY DURING THE PERIOD 2000-2020

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Foreign Direct Investment (FDI) as part of the Gross Fixed Capital Formation (FBKF) affected the Ecuadorian national economy in various ways, for example in promoting employment in the construction area; This study verified that the FBKF had an impact on FDI adding more than a thousand dollars for

every dollar that entered the country in FDI during the period 2000 to 2020. The Box Jenkins methodology used in this research has a quantitative, exploratory and descriptive approach, it was determined that the econometric model has significant relevance with the application of AR autoregressive tests (10). This research contributed to the area of National Finance by estimating the betas to make possible forecasts that are important in making economic policy decisions. Researchers who wish to continue with this type of research can use the methodology used to collect new results and possible comparisons.

Keywords: Gross Fixed Capital Formation (FBKF); Foreign Direct Investment (FDI); Box Jenkins, National Finance; Econometrics.

IDENTIFICATION OF FINE MOVEMENTS FOR OPTIMIZING ASSEMBLE TASKS

Heriberto Casarrubias Vargas, Noé Vásquez Godínez, Diana Esmeralda Jardon Vilchis, Brandon García Rodríguez, Juan Genaro Morales Santos, Gabriela Gaviño Ortíz
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In this work, a proposal is presented for the identification of fine movements in assembly tasks in the optimization of movements, with the objective of detecting basic movements, sequences of movements and determining redundancies or unnecessary movements; to generate much faster and more effective arming sequences. The proposed research is intended to reduce time and increase productivity. This document shows the work methodology and the progress made; the test and application scenario is documented. The corresponding graphs of the movements associated with the assembly task are presented and some movements made are visually identified.

Keywords: sequence analysis, micro movements, time and motion study.

ECODEMOGRAPHICAL ANALYSIS IN MEXICO OF MICRO-BUSINESSES FOR A RECOMENDER SYSTEM

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This work presents a methodology for the eco-demographic analysis of micro-businesses at Mexico; for this is needed obtain a collection of variables or main characteristics that measure the success of a business, that is, a good life expectancy. The use of machine learning techniques is proposed for the segmentation and grouping of characteristics that allow micro-businesses to be categorized according to their life expectancy, social development and eco-demographic of the locality. Based on this categorization, the development of a recommender system is proposed that, based on the characteristics of the locality, makes a proposal or idea of a microbusiness, and analyzes its viability by comparing it with similar localities. The purpose of the system is to determine what type of establishment in a certain locality is advisable to start.

Keywords: micro-businesses, economic growth, Artificial Intelligence

OPTIMAL PRICING AND OPTIMAL PRODUCTION LOT-SIZE INVENTORY MODELS WITH PRICE-DEPENDENT DEMAND

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Inventory models with optimal production and pricing policies for deteriorative items with constant price-dependent demand is considered in this study. The demand models found in the literature include constant, time dependent (linear, quadratic, exponential), linear price dependent and stock dependent among others. To wit, no study exists that uses constant price-dependent demand. Two models are developed: The first model uses optimal production lot-size and optimal pricing policy with constant price-dependent demand, the second model uses optimal cycle time with constant price-dependent demand for calculating price-break even point. The price-break-even point is identified in this model. Mathematical models are delineated for each model and relevant examples are provided to elucidate the proposed procedure. The objective herein is to obtain optimum order quantities and order intervals with respect to overall profit. Sensitivity analysis is provided for each of the two models. The necessary data was generated using Visual Basic 6.0.

Keywords: Inventory, Deteriorating, Constant price-dependent demand, Cycle time, sensitivity analysis, and Price Break-even point.

PHASE VELOCITY METHOD FOR COMPUTING DISPERSION CURVES IN CURVED PLATES

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Lamb waves are extensively used in non-destructive tests (NDT) in curved plates. Their phase and group velocities depend on the frequency and on thickness of the guide plate. In this work, we use the phase velocity method (PVM), in combination with finite element method (FEM), to compute the dispersion curve for phase velocity of an ultrasonic pulse traveling in a curved transversally isotropic plate. The FEM-PVM is based on the numerical solution of the wave propagation equations for several selected frequencies. To solve these equations, a second order difference scheme is used to discretize the temporal variable, while spatial variables are discretized using the finite element method. The open software FreeFem++ is used with quadratic triangular elements to compute the displacements. The phase velocity for a given frequency is obtained from the computed displacements at few points on the top of the plate.

Keywords: Lamb wave; finite element method; phase velocity method; dispersion curve; FreeFem++

APPLICATION OF BLOCKCHAIN TECHNOLOGY TO DEVELOP TRACEABILITY SYSTEMS FOR AGRICULTURAL PRODUCTS

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The final quality of agricultural products that reach the final consumer is strongly influenced by their origin and production and by all the processes they go through until they reach the customer. In this chain through which a product passes and is processed: farmer or producer, transporter, storage, processing or reprocessing, marketing, it is normal that there may be problems of trust since each participant may have its own management and control systems. Practice has shown that it is not feasible to pretend that a centralized system can solve this.

The concern and culture of consumers to know the origin and quality of the products they consume is increasingly growing. This situation forces companies to offer "certified" information to end consumers. However, until now, consumer confidence in this information has been scarce, since it is based on systems centralized by a single institution, which is not the real owner and controller of all participants. Therefore, the information stored can be manipulated, unreliable or unsafe from attacks, even when there are no bad intentions of participants.

This paper proposes the basis of a traceability system for the agricultural sector based on the use of Hyperledger Fabric enterprise blockchain technology with the aim of improving trust and decentralization of data between the different participants in the supply chain.

Keywords: blockchain, traceability, supply chain, farm products, decentralization

ELECTRONIC VOTING SYSTEM USING AN ENTERPRISE BLOCKCHAIN

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Conventional electronic voting systems use a centralized scheme. A central administration manages the entire voting process and has partial or total control over the database and the system itself. This may create some problems, accidental or intentional, such as possible manipulation of the database and double voting. Many of these problems have been solved thanks to permissionless blockchain technologies in new voting systems; however, the classic consensus method of such blockchains requires specific computing power during each voting operation. This has a significant impact on power consumption, compromises the efficiency and increases the system latency. However, using a permissioned blockchain improves efficiency and reduces system energy consumption, mainly due to the elimination of the typical consensus protocols used by public blockchains. The use of smart contracts provides a secure mechanism to guarantee the accuracy of the voting result and make the counting procedure public and protected against fraudulent actions, and contributes to preserving the anonymity of the votes. Its adoption in electronic voting systems can help mitigate part of the mentioned problems.

This paper proposes a system that ensures high reliability by applying enterprise blockchain technology to electronic voting, securing the secret ballot. In addition, a flexible network configuration is presented, discussing how the solution addresses some of the security and reliability issues commonly faced by electronic voting system solutions.

Keywords: Hyperledger Fabric, Blockchain, Election, permissioned, Non-FungibleToken (NFT), Hardware Security Module (HSM), SoftHSM, enterprise blockchain

ON THE USE OF EXPERIMENTAL DESIGN TO DERIVE MANAGERIAL INSIGHTS IN SUPPLY CHAIN MANAGEMENT: TWO ILLUSTRATIVE EXAMPLES

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Design of Experiments (DOE) is a mathematical methodology used for planning and conducting experiments as well as analyzing and interpreting data obtained from the results. This technique has been applied to a wide range of situations from medicine, social science, business, and technology. In this paper are illustrated two examples of the application of DEO in the field of supply chain management. The first problem corresponds to a two-stage supply chain that operates in make-to-order under a stochastic environment. In the second case is studied the design of an olive oil supply chain with the organic and conventional market segmentation and customers' preference for local products. The experimental design conducted in both scenarios allows the discovery of interesting managerial insights that cannot be directly obtained from the solution strategies proposed by each of the problems.

Keywords: experimental design, managerial insights, supply chain management

CLUSTERING ALGORITHMS AND TRAJECTORIES APPLIED TO THE ANALYSIS OF RESIDENTIAL SEGREGATION

Manuel Santiago Fernández Arias, Dafne García de Armas, Yudivian Almeida Cruz

Residential segregation is a silent evil that greatly affects modern society. Its study is of vital importance for decision-making in cities and for urban planning in general. There are many existing methodologies to model and analyze this phenomenon. However, new visions in this regard are always essential for the development and advancement of studies in this regard. In this work, on the one hand, a variation of the Simple Trajectories method is proposed, little known for the study of segregation, but with solid results in this regard. On the other hand, it is proposed to use an algorithm more applied in the literature: **Kmeans** that offers a global look at the problem. A Database is prepared with geolocated information from the Population and Housing Census of 2012. Both methodologies are compared on said data. Applying both algorithms, the existence of segregation in Havana is detected. Simple Trajectories are extremely effective when it comes to local analysis. The structural differences between the two

Keywords: Residential segregation, Kmeans, Simple Paths, Cluster

UNCERTAINTY AND ROBUSTNESS IN HUMANITARIAN LOGISTICS: AN OVERVIEW

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Natural disasters are very common nowadays. As a consequences human lives are lost and economical resources are destroyed, So, it is important to plan actions to mitigate these unwanted effects. The uncertainty associated to these phenomena is large. The solution shall somehow be robust, for instance the value of the losses shall be relatively small for a sufficient large set of possible cases. In this contribution we will present an overview of how it is considered in the literature. The discussed examples will show the use of different class of optimization models to describe the mitigation of the negative effect of natural disasters such as hurricanes.

Keywords: decision making, robustness, uncertainty.

GEOBASE: FIELD SURVEY MOBILE APPLICATION FOR DECISION MAKING

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A geographic information system is a software that integrates and relates various components that allow the organization, storage, manipulation and analysis of large amounts of data linked to a spatial reference. A variant of cartographic applications is destined for the collection of information about places of interest from forms. These applications are very useful for conducting scientific research, resource control, archeology, and solving optimization problems such as vehicle routing problems (VRP). Geobase is a cartographic mobile application that allows adding information associated with a location, using dynamic forms previously configured by the user in the form of categories developed in the university of Havana. In the proposed solution, flutter is used as a development platform, with Flutter_Map as a framework for the visualization of maps and a multilayer software architecture derived from clean architecture, which makes the application extensible to add functionalities in the future. This paper illustrates through two study cases how Geobase can be used to obtain input data for optimization algorithms. One of the study cases consists on the definition of geological interest sites of the ministry of energy and mines in order to make inventories, the other study case is the design of a tour for the rutas y andares program belonging to the office of the city historian.

Keywords: GeoBase, cartography, mobile app, optimization algorithms, data entry, decision making

KNOWLEDGE MANAGEMENT AND INNOVATION CAPACITY IN HIGHER EDUCATION ORGANIZATIONS

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Introduction. Knowledge represents the most important intangible asset of organizations to drive innovation and competitive advantage. Knowledge management is translated into greater efficiency in the use of resources, a better productive performance and optimal innovative processes. **Objective.** The purpose of the research is to analyze the relationship observed between knowledge management and the capacity for innovation in higher education institutions. The central hypothesis is that knowledge management is positively related to innovation capacity. **Method.** A descriptive, explanatory and confirmatory quantitative research was developed. Established the research problem and theoretically based the variables of generation of knowledge and innovation, we proceeded to analyze the relationship between the two constructs. Descriptive statistical, exploratory factor and confirmatory analysis tools were used. For the modeling and hypothesis testing, structural equation analysis was applied. The universe of study is 77 higher education institutions in the southeast of Mexico, where 8,603 people work. The sample size is 441 workers, and it was determined by means of cluster probability sampling, assuming a sampling error of 5%, a confidence level of 95%, and a variance of $p = .50$, $q = .50$. The field information was obtained by applying a structured questionnaire of 88 items on a Likert scale. **Results.** It was found that among the analyzed variables there is a correlation coefficient of 0.921; an estimated ratio of (1,267) and a standardized ratio of (.96), and a p-value (0.000), which provides evidence of the presence of a positive relationship between both constructs. **Conclusion.** Knowledge management positively influences the capacity for innovation in the higher-level educational institutions previously studied, thus confirming the hypothesis made.

Keywords: GeoBase, cartography, mobile app, optimization algorithms, data entry, decision making

PERSONAL CHARACTERISTICS OF WOMEN ENTREPRENEURS IN RURAL COMMUNITIES IN THE MUNICIPALITY OF CENTRO TABASCO

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In Mexico, millions of jobs have been lost due to the COVID-19 pandemic, the highest unemployment rates are focused in rural communities, especially in women; at the end of 2020, in Tabasco unemployment figures increased to 7.4%, indicating that out of every 10 unemployed in the entity 7 are women (INEGI, 2021), this increases the violence to which they are subjected within their own families. The objective of this article is to analyze the personal characteristics that motivate these women to become entrepreneurs, so that, once identified, they can be detonated in the development of enterprises, all this to combat the culture of subsistence that prevails in these communities. For this, a model of economic development is proposed and tested, through technology transfer, technical support, and entrepreneurship.

This study has collected samples from 16 rural communities in the municipality of Centro Tabasco, the authors applied non-experimental, descriptive-transectional research with a quantitative approach. The

results were obtained through the application of various statistical techniques such as: Bonnet test, KMO index, Bartlett's sphericity, Chi-square, confirmatory factor analysis, Crombach's Alpha, principal component analysis and structural equations.

The empirical findings show that there is a group of behavioral characteristics that emanate from the national culture combined with another group of personal characteristics of the inhabitants of these communities.

This study confirms that entrepreneurial development depends greatly on the personal and national characteristics of the inhabitants of rural communities and is negatively affected by the subsistence culture.

Keywords: Poverty, female entrepreneurship, subsistence culture, personal characteristics, technology transfer.

IMAGE RESTORATION USING A SMOOTH ORDER OF PARCS

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In this work, a detailed study of image restoration is carried out, especially the one based on the soft ordering of its patches (SOP). The studied strategy was developed in Python and the work with the subimages was parallelized. The temporal and spatial cost of it was also analyzed in detail. Using the developed implementation, we experimented on a small number of images with the proposed strategy in two case studies, with known and unknown original image. The results were compared with two other known restoration strategies from the literature and in the first case a metric was applied. As a result of the experimentation on the two selected image sets, the cases with better and worse results are described and improvement strategies and other applications of the SOP are proposed. Two new algorithms are proposed, the first one an adaptive variant for restoration and the second one an algorithm for compression with known and unknown mask.

Keywords: Patch-based processing, traveling salesman problem, permutation matrix, restoration, parallel permutation matrix, restoration, parallelization, compression, denoising.

LABORATORY OF TIMES AND MOVEMENTS FOR INDUSTRIAL ENGINEERING OF THE CU UAEM VALLE DE MÉXICO.

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Casarrubias Vargas

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Over the years, human capital has been a fundamental tool for optimizing any production process in any institution, since we currently live in a globalized world with high global competition. For this reason, it is necessary for human capital to be trained to acquire the necessary skills to improve some processes or a resource, thus leading to the success of the product or even the institution itself.

Method: A quantitative approach study is carried out in the CU UAEM VALLE DE MÉXICO that allows providing student teachers and industrial engineers so that they acquire practical knowledge by implementing the Lean Six Sigma methodology. It is a methodology for quality improvement, which is used in companies or micro-enterprises (SMÉs), which improve the management and processes of a company optimally. Derived from the above, this research is carried out in the laboratory of times and movements of Industrial Engineering of the University Center, using ergonomic cabins as equipment, which allow simulating different variables in the environment: such as temperature, light intensity, sound, humidity. relative to the air, among others.

Keywords: Lean Six Sigma, Quality, Ergonomic Cabins, KPI's

MATHEMATICAL MODELLING AND COMPUTATIONAL SIMULATION AS A TOOL TO UNDERSTAND AND DESCRIBE PROLIFERATION PATTERNS IN THE DIAGNOSTIC AND RELAPSES OF ACUTE LEUKEMIA.

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Recent experimental evidence suggests that acute myeloid leukemia may originate from multiple clones of malignant cells. There is almost no information on how cell properties change due to chemotherapy and relapse. Using mathematical model based on nonlinear ordinary differential equation, the impact of cell properties on the multiclonal composition of leukemia is investigated, first without taking into account the effects of chemotherapy and then incorporating the effects of chemotherapy. Using numerical method, the corresponding systems are solved for several sets of parameters. The simulations carried out imply that the increase in cell self-renewal is a key mechanism in the process of clonal selection, also that rapid proliferation and high self-renewal dominate in the primary diagnosis, while relapse after remission induced by therapy is triggered mainly by high self-renewal but more slowly by cell proliferation.

Keywords: systems of nonlinear differential equations, multi- compartment models, systems biology, clonal evolution, leukemia.

SOM to explore relationships between pathological history and symptoms of patients recovered from COVID-19

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May 21, 2022

Abstract

Many patients with mild or severe COVID-19 do not have a full recovery and present a wide range of chronic symptoms for weeks or months after infection. Studies suggest that the evolution of the disease and its subsequent sequels may depend of certain factors. The aim of this work is to show possible relationships between COVID-19 symptoms, pathological history and time of hospitalization of patients. For this purpose, two analyses by age groups are carried out. The first one considers pathologic history and length of hospital stay, and the second one, length of hospital stay, pathologic history and symptoms. Information from 229 patients from municipalities in the city of Havana, already recovered from the disease, is used. The KORRESP algorithm, a version of the stochastic SOM algorithm for categorical data, is used. For the identification of the clusters, reliability matrices, obtained from successive training of the same map, are used. As a result of the study, some conjectures can be made regarding relationships between the variables of interest. In all the considered age groups, stays of one to two weeks were the most common, together with the absence of symptoms and pathological history, and their combinations. As was the relationship between non-palate and non-olfactory symptoms. The rest of the relationships differed quite a bit among the different age groups considered, indicating that an analysis by age group is necessary.

Keywords: COVID-19 recovered patients, self-organizing maps, KORRESP algorithm, length of hospital stay, symptoms, pathological history.

SYMBOLIC REGRESSION FOR GENERALIZED LINEAR MODELS OF ODES

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For the study of an infectious disease mathematical models are used. Some of those models are based on ODEs that have the property of being linear with respect to the parameters. Researchers must choose a model that best approximates the observed data from a large number of possibilities. That selection can take a long time. To automate the process of finding such a model, this document presents a Neural Network Guided Genetic Algorithm that finds the system of ODEs which are linear with respect to the parameters that best fits the data set. The genetic programming approach explores the candidate systems while the neural network is used to narrow the search space. Performed experiments on three case studies (Lotka-Volterra, SIR, SIRZ) shows the effectiveness of this approach to find the sought model in each case in a short time.

Keywords: Symbolic regression for ODEs, linearity with respect to parameters, genetic algorithm, neural network

ISOGEOMETRIC SIMULATION OF ACOUSTIC RADIATION

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In this paper we discuss the numerical solution of the 2D Helmholtz equation with mixed boundary conditions. Inspired by medical applications, the so called radiation problem is solved, assuming that the wavenumber k in the Helmholtz equation is a complex function, with absolute value of order of thousands and depending on the spatial coordinates. In consequence, several numerical difficulties appear in the numerical solution of the computation of the approximated solution. To overcome these difficulties, we solve the radiation problem using the Isogeometric Analysis (IgA), a kind of modern generalization of the classical Finite Element Method (FEM). IgA uses B-spline functions to parametrize the geometry of the physical domain, and also to write the approximated solution of the differential equation. Our implementation of IgA with GeoPDEs software shows that isogeometric approach produces smooth solutions with small pollution errors and relatively few degrees of freedom.

Keywords: isogeometric analysis, Helmholtz equation, radiation problem.

INFERENCE FOR NONSTATIONARY TIME SERIES OF COUNTS WITH APPLICATION TO CHANGE-POINT PROBLEMS

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We consider an integer-valued time series $Y = (Y_t)_{t \in \mathbb{Z}}$ where the model after a time k_* is Poisson autoregressive with the conditional mean that depends on a parameter θ . The structure of the process before k_* is unknown; it could be any other integer-valued time series, that is the process Y could be non-stationary. It is established that the maximum likelihood estimator of θ computed on the non-stationary observations is consistent and asymptotically normal. Subsequently, we carry out the sequential change-point detection in a large class of Poisson autoregressive models. We propose a monitoring scheme for detecting change in the model. The procedure is based on an update estimator, which is computed without the theoretical observations. The asymptotic behavior of the detector is

studied, in particular the above results of inference in a non-stationary setting are applied to prove the consistency of the proposed procedure. A simulation study as well as a real data application are provided. **Keywords:** Time series of counts, Poisson autoregression, likelihood estimation, changepoint, sequential detection, weak convergence.

COMPARISON OF AUTOMATIC SLEEP STAGE SCORING METHODS

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The diagnosis of various types of sleep disorders requires the experts to perform sleep stage scoring. However, it is an arduous and repetitive task and, therefore, an important candidate for automation. The work seeks to evaluate several scoring algorithms based on Machine Learning from the scientific literature. The comparison is performed with the same experimental design, using EEG, EOG and EMG signals from the polysomnographic records of the ISRUC-Sleep dataset. It is compared the precision, memory and speed of methods based on Linear Discriminant Analysis, Support Vector Machines, Random Forests and Neural Networks. As a result, several of the analyzed algorithms reach high levels of accuracy, exceeding 75 %. Also, the performance of the algorithms is compared with the agreement between the experts that classified the records of the dataset.

Keywords: Polysomnography, Sleep Stage Scoring, Digital Signal Processing, Machine Learning

PESTICIDE CONCENTRATION MONITORING: INVESTIGATING SPATIO-TEMPORAL PATTERNS IN LEFT CENSORED DATA.

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Monitoring pesticide concentration is important given the major concerns for environmental safety and the likelihood for increased public health risks. An important aspect of this process consists in locating abnormal signals, from a large amount of collected data. This kind of data is usually complex since it suffers from limits of quantification leading to left censored observations, and from the sampling procedure which is irregular in time and space across measuring stations. The present work tackles precisely the issue of detecting spatio-temporal anomalies in pesticide concentration levels, and introduces a novel investigation method for dealing with spatio-temporal heterogeneity. The latter combines a change-point detection procedure applied to the series of maximum daily values across all stations, and a clustering step aimed at a spatial segmentation of the stations. Limits of quantification are handled in the change-point procedure, by supposing an underlying left-censored parametric model, piece-wise stationary. Spatial segmentation takes into account the geographical conditions, and may be based on river network, wind directions, etc. Conditionally to the temporal segment and the spatial cluster, one may eventually analyse the data and identify contextual anomalies. The proposed procedure is illustrated in detail on a data set containing the prosulfocarb concentration levels in surface waters in Centre-Val de Loire region.

Keywords: pesticide concentration monitoring, left censored data, change point detection, anomaly detection, Pareto front, water pollution, prosulfocarb.

FACE EMOTION RECOGNITION TO DETERMINE THE PERFORMANCE OF A ZUMBA FITNESS CLASS TO REDUCING STRESS

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Emotions are inherent characteristics of human beings, manifesting themselves in several ways through the face, voice, body language, among others. In this sense, the face is certainly the most studied channel. The psychologist Paul Ekman proposed a scheme of seven basic emotions in the 70's, work that to date is

taken as reference. The automated recognition of emotions in the human being is an important area of application of computing sciences, changes in specific biometric parameters are studied to carry out the analysis and classification of the emotions, allowing the development of applications in areas such as marketing, support systems for driving, safety, pedagogy, among others.

In this paper, the development of a system for recognizing individual face emotions within a Zumba Fitness group, to determine the performance of the session in stress reduction is presented. For the above, the Haar algorithm is used to detect faces in an image and subsequently a convolutional artificial neural network to classify the emotions of every face.

The efficiency of the system is 65.04% in face detection and 80.76% in emotion recognition. Finally, when contrasting the initial and final emotions of participants in the group, approximately 82% present an improvement in their mood, specifically joy is the emotion most frequently detected and considering that the objective of a Zumba fitness class is to increase self-esteem, reduce stress, enjoy and be happier, it can be concluded that the class has been successful.

Keywords: artificial intelligence, face detection, automatic emotion detection, stress reduction

APPLYING BLOCKCHAIN FOR AVIATION FUEL TRACEABILITY

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The traceability of the process through which aviation fuel passes, from its importation or production until it finish in an aircraft, requires rigorous regulations and regular auditing. This process generates a large number of documents and controls.

When regulations are not accomplished it is clever to determine the responsibilities of the individuals and the entities involved in this process. It is essential that documentation be immutable; nevertheless, it is very complex to achieve if the documentation consists of traditional files and centralized applications, especially because of the diversity of participants in this type of process.

Due to its decentralization nature, its application of cryptography, and the consensus mechanisms it proposes, blockchain technology has proved to be suitable for this type of scenario. This guarantees that what is recorded in the network cannot be changed, be completely transparent, and be accessible to all different participants without loss of privacy. It creates trust in scenarios where business participants do not have to trust each other. Therefore, blockchain becomes an appropriate technology for this kind of applications for product traceability processes that go through different entities and that are complex to control centrally. The current work presents a use case of applying Hyperledger Fabric (HLF) blockchain technology. HLF was designed to create consortia in such business contexts as those involved in a scenario like this one of fuel traceability. This paper presents the architecture of the proposed network and the entities participating in this process organized according to the Hyperledger Fabric model. The proposed smart contracts (chain code), once deployed in the network, will form the functionality that will track and control the assets from a transaction logic.

Keywords: Traceability, Blockchain, Hyperledger Fabric, Smart Contracts, Chaincode, Assets.

INFLUENCE OF STOCHASTIC NOISE ON HEMATOPOIETIC RECOVERY AFTER AUTOLOGOUS BONE MARROW TRANSPLANTATION

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The application of differential equations systems in stem cell maturation processes allows the representation and predictive visualization of the results obtained from initial clinical data. In the present work, a study of the cell maturation process after chemotherapy is carried out. Starting from the

deterministic models that represent this process, a case is chosen to study, from which the probabilistic model is presented, which has the influence of stochastic noise. The proposed probabilistic model is solved for the case of eight compartments, this represents the maturation of hematopoietic cells in obtaining neutrophilic granulocytes, and variations in the noise diffusion coefficients are applied, conclusions are reached on the effects of the representation stochastic from its representation using Mathematica software. In addition to a biological interpretation of the mathematical results obtained in the representation of the stochastic system, including the influence of stochastic noise in the equations of the proposed system.

Keywords: stem cells, chemotherapy, probabilistic model, stochastic noise, neutrophilic granulocytes

TEMPORAL EVOLUTION OF A LEUKEMIC LINE THAT COMPETES WITH HEALTHY HEMATOPOIESIS: MATHEMATICAL MODELING DESCRIBES SOME CAUSES OF LEUCOMOGENESIS.

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The stem cell cancer hypothesis has become one of the most important paradigms in biomedical research. In recent years, evidence has accumulated for the existence of stem cell-like populations in different types of cancer, especially in leukemias. This work shows a mathematical model of the dynamics of cancer stem cells in leukemias recently developed at the Institute of Applied Mathematics of the University of Heidelberg, Germany. The model is applied to compare the cellular properties of leukemic stem cells with those of their benign counterparts. A linear stability analysis shows necessary and sufficient conditions for the expansion of malignant cell clones, based on fundamental cellular properties. This approach reveals different cancer initiation scenarios and provides qualitative guidelines about possible treatment strategies of interest to hematologists.

Keywords: systems of differential equation, multi-compartment models, stem cell cancer, leukemic stem cells

BLOCKCHAIN-BASED SYSTEM FOR DISTRIBUTION CONTROL OF MEDICINES ON CUBA

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The pharmaceutical supply chain in Cuba (PSCC) consists of various parties involved, including BioCubaFarma as a drug manufacturing entity, distributors, transporters, pharmacies, hospitals and patients.

The complexity of the flows of products and transactions in the PSCC requires an effective traceability system to determine the current and previous properties of the products. A system that links all the parties involved and builds a registry of the transfer of custody of a certain pharmaceutical product from its production to its medication by medical personnel and consumption, would undoubtedly help in the planning of distribution according to the needs of the different territories.

This system allows carrying out audits and detecting fraudulent actions, it would also prevent hoarding and facilitate control of the distribution of additionally, automating the track and trace process provides a significant benefit for monitoring and ensuring product safety.

Blockchain-based drug traceability offers an alternative to create a distributed shared data platform for an immutable, trustworthy, accountable and transparent PSCC system.

We will be talking about the answers to the questions asked, the design of this system, its implementation and the future challenges that are imposed.

Keywords: Traceability, Blockchain.

A NEW VIEW ON RISK MEASURES AND ACCEPTANCE SETS

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Risk measures associated with acceptance sets are subject of many research topics (see, e.g., Artzner et al. [1], Baes et al. [2], Farkas et al. [3], and Föllmer, Schied [4]). Especially, in the current environment of rising regulatory restrictions (which began by observations of institutional misbehavior due to the financial crisis 2008), it is from special interest to find optimal solutions for optimizing the institutional capital position. In this talk, we present the main results of our research outcomes to that mathematical economical problem published in [5], [6], and [7]. Within a one-period-model of a financial market with a vector space of capital positions X , a subspace of eligible payoffs $M \subseteq X$ of multiple eligible assets, a pricing functional $\pi: M \rightarrow R$, and an acceptance set $A \subseteq X$, we focus on the optimization problem

$$(P_{\pi}(X)) \quad \min \pi(Z) \quad \text{s.t. } X+Z \in A, Z \in M$$

with optimal value $\rho_{A,M,\pi}(X)$ and solution set $E(X)$. We present new results, e.g., with respect to the finiteness, (strict) sublevel sets, and level lines of the corresponding nonlinear functional $\rho_{A,M,\pi}: X \rightarrow R$, and a generalized characterization of the solution set $E(X) \subseteq M$ of $(P_{\pi}(X))$. Moreover, we outline the relationship of efficient and weakly efficient points of the acceptance set A to cost-optimal acceptable positions $X^0 \in A$, resulting by solutions of $(P_{\pi}(X))$ as $X^0 = X + Z$ with $Z \in E(X)$.

Keywords. Acceptance sets, Regulation, Capital positions, Financial Mathematics, Investments, Cost minimization, Scalarization Methods, Translation invariance, Nonlinear functionals, Risk measures, Efficiency, Ordering cones.

References

- [1] Philippe Artzner, Freddy Delbaen, Jean-Marc Eber, and David Heath. Coherent Measures of Risk. *Mathematical Finance*, 9(3):203–228, 1999.
- [2] Michel Baes, Pablo Koch-Medina, and Cosimo Munari. Existence, uniqueness, and stability of optimal payoffs of eligible assets. *Mathematical Finance*, 30(1):128–166, 2020.
- [3] Walter Farkas, Pablo Koch-Medina, and Cosimo Munari. Measuring risk with multiple eligible assets. *Mathematics and Financial Economics*, 9(1):3–27, 2015.
- [4] Hans Föllmer and Alexander Schied. *Stochastic finance: An introduction in discrete time*. De Gruyter graduate. de Gruyter, Berlin and Boston, fourth revised and extended edition edition, 2016.

IMPLEMENTACIÓN DE LEAN OFFICE PARA LA TROPICALIZACIÓN DEL SISTEMA DE GESTIÓN DE CALIDAD DE LA EMPRESA DOGO S.A. DE C.V.

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Over the years, the great importance of implementing a quality management system based on ISO 9001 has been shown, as it provides multiple organizations with benefits that over time translate into more solid and profitable companies. Currently, most organizations seek certifications in standards according to their line of business, such as: health, environmental, technological, etc.

Reactivos y Limpieza DOGO S.A. de C.V. (R.L.D.) is a Mexican company dedicated to the manufacture of cleaning products, with around 500 branches with a presence in various states of the country. Dogo seeks to be a company with high quality in products, as well as in its process. Following the ISO 9001-2015 standard. Its main objectives are the satisfaction of internal and external customers, not neglecting the cost of operation and continuous improvement as its main objectives.

A well-structured management system makes it possible to improve the efficiency of the organization at all levels and increase the motivation of the workers. All this results in quality products, services and greater customer satisfaction.

This project deals with the implementation of a Software (EUROSOFT) for the quality management system. It was born from the need to standardize and keep documented the processes of the R.L.D. To improve the efficiency of the organization and in each of its distribution centers, Guadalajara cedis, Agrícola Oriental cedis and Villa Hermosa cedis. It seeks to keep the entire organization informed on improvements made to maintenance processes, and the correct dissemination of documentation to the company, seeking to standardize the operation.

The department of the Quality Management System of R.L.D. is in charge of carrying out the tropicalization of the S.G.C. through the EUROSOFT software.

This area has all the documented information about the R.L.D. processes. Looking for process improvement.

Keywords: Lean Office, Sistema de Gestión de la Calidad, Dashboard.

PRELIMINARY METAHEURISTIC SCHEME FOR SOLVING THE SIGNAL CONFIGURATION OPTIMIZATION PROBLEM

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Traffic planning and management is an importance task for governments to achieve a proper function in of the cities. The configuration of road signs and traffic lights is part of this process. The selection of an appropriate configuration is modelled as a variant of the traffic light cycle optimization problem (TLCOP), which is NP-Hard. To evaluate the impact of each configuration, agent-based simulations can be performed. Based on the importance and complexity of the problem, the objective of this paper is to present and evaluate a metaheuristic scheme to solve it and analyze solutions obtained. The algorithms were applied to six zones of Havana, Cuba. Among all the algorithms used, the genetic algorithm obtained the best performance.

Keywords: metaheuristics, road signs, agent-based simulation, traffic lights, optimization

METRICS FOR THE EVALUATION AND GENERATION OF SCHOOL COURSES

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Ideally, school courses should have characteristics that encourage student participation and interaction with the subject. This work proposes a tool to evaluate different characteristics in the courses of the subject Numerical Mathematics taught at the Faculty of Mathematics and Computer Science of the University of Havana. The course is modeled as a game that reflects the teacher/student interactions during the lesson period to carry out these evaluations. Games are simulated, and a set of proposed metrics are used to carry out the evaluation. Also, the feasibility of using genetic algorithms to design courses in an automated way is analyzed.

Keywords: Automatic Game Design, Course Simulation, Metrics, Genetic Algorithm, Players, Game, Evaluation

AN ALGORITHM FOR AUTOMATICALLY FORECASTING UNI-VARIATE TIME SERIES. A STUDY FOR FORECASTING THE NATIONAL CONSUMER PRICE INDEX OF MEXICO

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The present study compares the accuracy of automatic univariate time series forecasting methods for the value of the National Consumer Price Index of Mexico, for which monthly data from 1969 to 2021 are used. Two of the main methods are presented in the study area: 1) The Exponential Smoothing State Spatial Models (ETS) and 2) The Autoregressive Integrated and Moving Average (ARIMA) models. A computational algorithm is developed for the identification of a data generating process to estimate the optimal parameters. The second method presents a better performance in the calculation of the predicted values. The results show the usefulness of automatic forecasting methods when proper procedures are followed.

Keywords: ARIMA models; exponential smoothing; model comparison.

ICCE: SOFTWARE TO CALCULATE EXTREME CLIME CHANGE INDICATORS

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Due to the constant difficulties that climate change has in daily living, it is necessary to create tools that provide a detailed study of the effects of these changes. The most important need is to establish a common ground to study climate change. The use of climate change indicators is one of the directions to achieve this common ground. These indicators show the behavior of what is considered by the experts as the major effects of climate change. Although, indicators on itself don't provide enough information since more often than not they constitute high volumes of data. To facilitate the study and comprehension of the indicators, a software was developed to automatize the part of the process of study of the indicators. The tools provided are, trend analysis and point of change through non-parametric tests such as Kendall-Mann and Pettitt tests and the analysis of the return periods through the extreme values theory more specifically the generalized extreme values distribution. It is described a methodology focused on the use of these tools that will accommodate the work of the Institute of Meteorology experts.

Key Words: Climate change indicators, trend, change point, return periods, Extreme Value, non-parametric testing, software.

VERISOFT: SOFTWARE OF VERIFICATION ANALYSIS FOR CLIMATE PREDICTION IN CLIMATOLOGICAL VARIABLES.

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In recent years it has been evidenced in our country, and in the world, a significant increase in rainfall, as well as other effects attributed to this change that affect different sectors. Therefore, the prognosis of those change is of vital importance to man, especially in regard to the role he plays weather forecasting in decision-making before the possible impact of a meteorological phenomenon dangerous; Therefore, the analysis of the verification of the climatic prediction of meteorological variables is important for the Institute of Meteorology, for which a software was developed with the aim of being able to verify the models used for the forecast of meteorological variables, through methods of check. For the verification analysis, a multicategory method was used with 3 types of categories with respect to the norm and the

calculation of metrics used by the Institute. The computational tool presented is a desktop application called VeriSoft, developed as a web application using React for the frontend and Flask to develop the back end API, and using Electron to package said web implementation to a desktop application. A methodology is described to evaluate the behavior of the forecasts during a period of time. Through its use, it was possible to observe the behavior of the metrics and the observed and predicted values obtained from November 2016 to May 2020 in the Western, Central and Eastern regions of the country, using 1981-2010 as a standard.

Keywords: Software, Verification, Forecasting, Precipitation.

PRODUCTION INVENTORY MODELS FOR DETERIORATING ITEMS WITH PRICE-DEPENDENT DEMAND INTEGRATED WITH TIME-DEPENDENT DEMANDS –IN FORTH ORDER EQUATION

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Production Inventory models for deteriorative items with Price-Dependent Demand (PDD) integrated with time dependent demand are accounted in this study. The demand models found in the literature include constant, linear, quadratic, exponential, price dependent, and stock dependent among others. To my knowledge, no study exists that uses PDD integrated with time-dependent demands. Three models are developed: The first model uses price-dependent demand (PDD), the second model uses PDD integrated with linear time-dependent demand, and the third model uses price-dependent demand (PDD) integrated with quadratic time-dependent demand. Mathematical models are delineated for each model and relevant examples are provided to elucidate the proposed procedure. The objective herein is to obtain optimum order quantities and order intervals concerning the overall cost. Sensitivity analysis is provided for each of the three models. The necessary data was generated using Visual Basic 6.0.

A BAYESIAN HIERARCHICAL ESPATIO-TEMPORAL MODEL FOR THE DIABETES MELLITUS MORTALITY IN CUBA, DECADE 2011 TO 2020

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Introduction: Diabetes mellitus is considered a health problem worldwide, due to its high rates of prevalence, incidence and number of deaths. The geographical distribution of health events is one of the main tools of public health decision makers to assess the health status of the population, define priorities and allocate resources and to monitor health problems. The main objective of this work is to describe the temporal spatial distribution of mortality by Diabetes Mellitus in the municipalities of Cuba, decade 2011 to 2020. **Material and methods:** A small-area ecological study was designed using the municipalities as the unit of analysis. A spatial-temporal Bayesian hierarchical model was adjusted by age group and sex to estimate the specific mortality rate of each municipality, together with its trend over time. **Results:** For the study period, over 90% of the municipalities exhibited a trend of decreased or stable mortality for all age and sex groups. About 10% of the municipalities showed a tendency to increase in both: female and male mortality for the groups of ages 65 years and over. **Conclusions:** The study showed a dynamic Geographic Distribution of Mortality by Diabetes Mellitus in Cuba, with a different pattern for each year, age group and sex.

The computer system used is the WinBUGS 1.4.

Keywords: Geographic distribution of mortality, Diabetes Mellitus.

ON PATTERN DETECTION WITH DISCRETE SHAPELET TRANSFORM II: SHAPELET ESTIMATION, MULTILEVEL DETECTION AND NOISE ROBUSTNESS

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The Discrete Shapelet Transform (DST-II) localizes the time-support of frequencies, and, at the same time, it matches a pattern embedded on a discrete-time signal. For this purpose, a system of non-linear equations must be solved. This system is given by constraints on the filter coefficients, such as orthogonality, unitary energy, vanishing moments, and pattern matching. In this contribution, we propose to combine Anderson's method as pre-iteration, followed by Powell's method for solving the system, with the aims to obtain a suitable high-pass filter. We evaluated the solution accuracy, the frequency and phase response of the filter. Regarding the pattern detection algorithm, we proposed to take the detail coefficient with the highest value of a normalized similarity measure which emphasized the presence of zeros in the DST-II. Comparative experiments showed an improvement in detection concerning other wavelet filters. In addition, we examine the effectiveness of the DST-II in detecting pattern repetition and dilation, and its robustness to noise. In general, we obtained accurate detection of repeated patterns. The modest robustness of the detection to Gaussian and Poisson noise was verified. For patterns between similar signal fragments, the detection of its dilation was not successful. It is recommended to attenuate the signal noise to obtain an accurate detection.

Keywords: wavelet filter design; adapted wavelet; time-frequency-shape joint analysis; Discrete Shapelet Transform; Discrete Wavelet Transform.

SPATIO-TEMPORAL EEG SOURCE DECOMPOSITION MODEL FOR ESTIMATING CHANGES IN NEURAL CONNECTIVITY RELATED TO COGNITIVE AGING

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One of the main challenges of neuroscience is the reliable estimation of brain connectivity from noninvasive high temporal resolution measurements taken on or over the scalp, i.e. from electroencephalography (EEG) or magnetoencephalography (MEG). Estimating the activity and connectivity of/among the neuronal masses at a mesoscopic level, might provide the basis for an objective association between cognitive neurosciences and brain imaging, to allow in vivo assessment of normal and abnormal brain states. Although there have been advances in the statistical techniques to estimate EEG/MEG source activity; there are fundamental difficulties limiting their use and they cannot directly offer information on the connectivity among active sources.

The present work explores two approaches for the estimation of brain activity and connectivity at the source level. Firstly, we propose a procedure with a first step for efficiently estimating the sparse spatio-temporal sources, and a second step for calculating connectivity from the sources' time series. Secondly, we develop the theory of a multivariate decomposition state-space model to estimate the EEG source activity and connectivity simultaneously. Both approaches could be applied to estimate the neural connectivity from the extracted time series in the time domain, or from cross-spectra in the frequency domain for the different spectral bands of the EEG.

Synthetic data were used for comparing results from the two approaches, according to well-known measures of reconstruction quality. Then, neural sources and connectivity were obtained from resting-state EEG of healthy elders, to study the relationship between cognitive aging and motor ability decline.

INFLAMMATION INDEX IN HEALTHY, SICK AND CONVALESCENT PATIENTS COVID-19

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Introduction: Neutrophil-Lymphocyte Ratio (NLR) and Platelet-Lymphocyte Ratio (PLR), are two indexes of inflammation based on reported neutrophil (N), lymphocyte (L), and platelet (P) counts as prognostic and predictive factors in healthy, sick and convalescent Covid-19 patients. **Objectives:** The aims of this study were to evaluate the sex and age differences in the contribution of NLR and PLR to severity and mortality using a sample of Covid-19 patients infected with SARS-CoV-2.

Methods: A total of 324 healthy subjects, 191 moderate patients, 155 serious, 8 critical patient and 49 convalescent patients. Area under the curve, sensibility, and specificity were calculated for these ratios to identify optimal cut-offs according to gender and age to predict severity and mortality in Covid-19 subjects. All statistical analyzes were performed with SPSS version 25 software. Differences were considered statistically significant when $p < 0.05$.

Results: The first analysis revealed that higher NLR and PLR for moderate, serious and critical patients treated with nimotuzumab compared with itolizumab. The second analysis revealed that the comparison between the NLR and PLR before and after was not significant in patients treated with itolizumab. The third analysis revealed that the comparison between the pre and post NLR and PLR was significant in moderate and serious patients treated with nimotuzumab. Finally, the comparison between the NLR and PLR before and after was not significant in healthy subjects and convalescent patients.

Conclusions: PLR is predictive markers of lung damage. PLR is the best to discriminate patients with damage. Prednisone could be used in recovered patients with lung damage. Nimotuzumab could be used in moderate and serious patients.

Keywords: NLR, PLR, moderate, serious, critical, recovered COVID 19, lung damage

ANALYSIS OF AN INSTRUMENT FOR MEASURING SCIENTIFIC ALPHABETIZATION WITH THE RASH MODEL

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For the construction of a measurement instrument there are several causes such as that there is no other to measure a certain variable also because the existing instruments have psychometric deficiencies or that do not incorporate any important part to analyze said variable in addition to the existing ones could have become obsolete, in the review of the literature on scientific literacy in Spanish very specific instruments are regularly found, The Scientific Literacy Test (PAC) integrates different areas of science and this work provides the analysis of some of its psychometric properties.

The Rasch model disseminated in the texts of Item Response Theory includes the solutions of joint measurement, in addition to allowing us to analyze the interactions between people and items and this gives a great diagnostic richness

The present study uses the data collected with the Scientific Literacy Test (PAC) designed for the Zetina study (2016) where 1035 students from a public university voluntarily answered from the first semesters of the 690 and 345 degrees of the postgraduate degrees offered. The instrument is considered to adequately measure scientific literacy and some items can be adjusted to improve its performance on the test.

Keywords: Model Rasch, Scientific Literacy, Unidimensionality