17th African Conference on Research in Computer Science and Applied Mathematics
Digital Sciences in Africa

📅 23-26 Nov 2024 📍 University of Bejaia, Algeria

ABSTRACT BOOK

CARI'2024

17th African Conference on Research in Computer Science and Applied Mathematics
Digital Sciences in Africa

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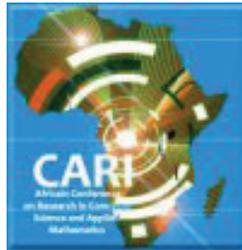
17th **AFRICAN CONFERENCE ON RESEARCH IN COMPUTER SCIENCE AND APPLIED MATHEMATICS - DIGITAL SCIENCES IN AFRICA-**

$$W\left(\propto, x, \xi\right) \Rightarrow \max$$

P REFACE

Thirty-two years ago, mathematicians, computer scientists, specialists in various digital disciplines, and business managers came together in Yaoundé, Cameroon (1992) to ≪ build ≫ the 1st **CARI** - African Conference on Research in Computer Science and Applied Mathematics. This event emerged from international cooperation between African, European, and international research institutes. Organized every two years since its first edition in Yaoundé in 1992, the **CARI** is more than just a scientific meeting, it is a dynamic environment of collaboration that brings together researchers and decision-makers in the fields of computer science and applied mathematics.

Since then, CARI has traveled across Africa: **Cameroon (1992), Burkina Faso (1994), Gabon (1996), Senegal (1998), Madagascar (2000), Cameroon (2002), Tunisia (2004), Morocco (2008), Ivory Coast (2010), Algeria (DGRSDT, CERIST, ESI, USTHB, CDTA, 2012), Senegal (2014), Tunisia (2016), South Africa (2018), Senegal (2020), and Cameroon-Tunisia (2022).**

Today, the 17th **CARI'2024** Conference is taking place in Béjaia (Algeria). It is organized under the auspices of **ASDS** (African Society in Digital Sciences) in partnership with several specialized institutions in Algeria (**DGRSDT**, **ATRST**, University of Béjaia, **SMA** - Algerian Mathematical Society, **A2T2** - Algerian Society for Technology Transfer, **EPB** - Port Enterprise of Béjaia, . . .) and internationally (**INRIA** - National Institute for Research in Computer Science and Automation, **IRD** - Institute of Research for Development, **CIRAD** - Center for International Cooperation in Agronomic Research for Development, #DigitAg, . . .).

The scientific and international reputation of the local organizers (**LaMOS** Research Unit (http://www.lamos.org) and the **LIMED** Laboratory), was pivotal in selecting Béjaia as the host for this 17th edition. We hope to meet the expectations and challenges of this important event. Indeed, the committees received 210 communication proposals from 28 different countries (including 16 African countries). These submissions were reviewed by a **TPC**-Technical Program Committee (chaired by Prof. K. Barkaoui, Beït el Hikma Tunis and CNAM Paris), which mobilized 146 reviewers.

The scientific program, which reflects the richness and diversity of research carried out on the African continent in particular, focuses on work likely to contribute to scientific and technological development, environmental awareness and natural resource management.

The first day of the event (Saturday, November 23) will be dedicated to a workshop [on international cooperation, led by S. Arnaud, R. M. Ahouandjinou (IFRI, UAC, Benin), Hélène Kirchner (INRIA, France), and César Viho (IRISA, France)], and to a specialized workshop, ≪**DAAfrica'2024** - Data Science for Agriculture in Africa≫,

coordinated by Paulin Melatagia (University of Yaoundé) and Mathieu Roche (CIRAD, France), with 40 registered participants. The final day (Wednesday, November 26, 2024) will feature the General Assembly of the **ASDS** (African Society in Digital Sciences). Additionally, a rich social and cultural program will accompany the scientific event.

The four plenary lectures will be delivered by leading experts (G. Yero - University of Cadiz, F. Toumani - CNRS Clermont-Ferrand, H. Sahraoui - University of Montreal), including Professor Salissou Moutari (Queen's University Belfast, United Kingdom), a graduate of our Operational Research Department at the University of Béjaia (Engineer, class of 2001). This is an opportunity to highlight our institution's policy toward Africa, initially directed toward the Maghreb in the early 1980s and subsequently toward Sub-Saharan Africa from the 1990s. We take this opportunity to honor the memory of Professor Kwansi Adam (Kumasi University, Ghana), with whom we collaborated as early as 1990 on the **SEAM** African Conferences (Structural Engineering Analysis and Modeling). The training initiatives of our university even extended to supervising engineering theses on local topics (such as the performance evaluation of the electrical network of Niamey city, for the **Nigelec** company).

The **CARI'2024** Committees extend their gratitude to all those who contributed, directly or indirectly, to ensuring that this 17th edition reflect the scientific and technological advancements of recent years.

To all **CARI'2024** participants, we wish you a warm welcome to Béjaia.

C/President of the 17th **CARI'2024**
Pr. Djamil Aïssani, Director of Research

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Program CARI 2024
23-26 November - Bejaïa, Algeria

	Sunday 24 November			
08:30-09:00	**Welcome participants**			
9:00-10:00	**Opening session**			
10:00-11:00	**Invited Talk 1** Optimisation in Cataract Surgery: Estimating personalised intraocular lens power Salissou Moutari , Université Belfast, United Kingdom			
11:00-11:30	Coffee break			
11:30-13:00	1CS - Optimization and Heuristics 1 pp. 02	2CS - Cluster Analysis pp. 03	1AM - Control, Optimization and Stochastic Methods1 pp. 04	2AM-Fractional Dynamics for Epidemic Models I pp. 05
13:00-14:30	Lunch			
14:30-15:30	**Invited Talk 2** Graph theory and application to social networks G.Yero, Universidad de Cadiz, Spain			
15:30-16:00	Coffee break			
16:00-18:00	**Session Short Papers** Discussions and exchanges in front of posters and Oral presentation (8-10 minutes for each paper)			
18:00	**Social Event (Musical Concert)**			
	Monday 25 November			
09:00-10:00	**Invited Talk 3** Ontology-based query answering Farouk Toumani , Université Clermont Ferrand, LIMOS- CNRS, France			
10:30-12:30	3CS - Optimization and Heuristics 2 pp. 16	4CS - Reactive Systems pp. 17	3AM - Predator - Prey Systems 2 pp. 19	4AM- Partial Differential Equations Modeling pp. 20
12:30-14:00	Lunch			
14:00-15:30	5CS - Knowledge Discovery, Natural Language and pp. 21	6CS-Information Security pp. 23	5AM - Fractional Dynamics for Epidemic Models 2 pp. 24	6AM - Control, Optimization and Stochastic Methods2 pp. 24
15:30	**Social Event (Guided tour of Bejaia and surrounding area)**			
	Tuesday 26 November			
08:30-09:30	**Invited Talk 4** Generative AI for Software Engineering Houari Sahraoui, Université de Montréal, Canada			
09:30-10:00	Coffee break			
10:00-12:00	7CS - Deep and Machine Learning pp. 28	8CS-Image Processing and Computer Vision pp. 29	7AM - Predator - Prey Systems 1 pp. 31	8AM - Performance and Reliability Evaluation pp. 32
12:00-12:30	**Closing session**			
12:30-14:00	**Lunch**			
14:00-16:30	**ASDS General Assembly**			

DETAILED PROGRAM OF CARI 2024

18h00 :   **Social Event (Musical Concert)**

Monday 25 November

09h00-10h00 :   **Invited Talk** : Farouk Toumani : Ontology-based query answering   15

10h00-10h30 :   **Coffee break**

10h30-12h30 :

12h30-14h00 :   Lunch

14h00-15h30 :

Tuesday 26 November

INVITED TALK

Salissou Moutari
Associate Professor
Mathematical Sciences Research Centre
School of Mathematics and Physics
Queen's University Belfast
University Road Belfast, BT7 1NN
United Kingdom
Email: s.moutari@qub.ac.uk
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Optimisation in Cataract Surgery: Estimating personalised intraocular lens power

Salissou Moutari

Cataract Surgery (CS) and Refractive Lens Exchange (RLE) are the most routinely performed ophthalmic procedures worldwide. Nowadays, the emphasis in CS and RLE has shifted from technical concerns about the safe removal of the cloudy lens to the minimisation of post-operative refractive errors, i.e., blurred vision, caused by the miscalculation of the power of the implanted synthetic intraocular lenses (IOL). However, despite significant advances in modern microsurgical techniques, biometry methods, and new IOL technologies, refractive errors, following CS and RLE, are still frequent, whereas patients' expectations regarding refractive outcomes have increased over time. Current industry standard approaches, referred to as modern formulae, for IOL power calculation are based on thin lens geometric optics combined with a single ad hoc regression model, generally devised from clinical experience and manipulation of retrospective empirical data. The major shortcoming of these approaches is imputable to their predictive models, which are not powerful enough to handle complex scenarios, namely eyes with uncommon characteristics. This study leveraged the capabilities of machine learning alongside optimisation to devise a new approach for a personalised and more accurate estimation of IOL power, for both eyes with common and uncommon characteristics. The proposed approach is not only accurate but also robust enough to withstand the variations of patient anatomical and physiological characteristics, IOL design as well as surgical techniques and instruments specific idiosyncrasies. Ultimately, this new approach produced a new perspective, which intends to revolutionise the way IOL power calculation problems have been addressed over the last three decades by both academic and eye-care professionals

New heuristic order based on tree-decomposition for solving CSPs

Ouali Lillia[a], Amroun Kamal[a], Bezoui Madani[b], Younsi Zineb[a]

Laboratory of Medical Informatics (LIMED), University of Bejaia[a], LINEACT Laboratory, CESI, 06200 Nice, France [b]

The Constraint Satisfaction Problem (CSP) represents a pivotal area of study within artificial intelligence, offering a broad spectrum of applications from scheduling to resource allocation. Despite significant advancements in the development of algorithms and heuristics, the efficient resolution of large and intricate CSP instances continues to pose a considerable challenge to the research community. Traditional heuristics often fail to efficiently navigate the solution space, struggling to converge on optimal solutions within a reasonable timeframe. This paper introduces a novel heuristic, rooted in tree-decomposition techniques, specifically designed to enhance the efficiency of CSP solvers. Our approach leverages an innovative variable and value ordering strategy, which systematically reduces the search space and the computational demands. We conducted extensive experiments using a set of benchmark CSP instances to validate the efficacy of the proposed heuristic. The results demonstrate a marked improvement in solving efficiency, particularly evidenced in challenging instances from the *modified-renault* benchmark, such as *renault-mod-4_ext* and *renault-mod-32_ext*. These findings underscore the potential of our heuristic to significantly advance the state-of-the-art in CSP solving methodologies.

Combinatorial optimization of banana clean seed reliance

Israél Tankam Chedjou[a]

Institut Agro, Univ Rennes, INRAE, IGEPP, 35000, Rennes, France[a]

Bananas, the world's most popular fruit, face significant damage from the burrowing nematode *Radopholus similis*. Fallow deployment effectively controls nematode populations by creating unfavourable soil conditions for the parasite. Despite the success of fallowing, it is essential to uproot and replant banana plants with clean seeds. Previous research focused on optimizing banana crop yield through systematic fallowing and clean seed replanting. However, a broader issue arises regarding the trade-off between allowing natural vegetative reproduction, which is cost-free but supports pest proliferation, and planting clean seeds which induce costs but reduce pest populations. This paper optimizes the number of cropping seasons with vegetative reproduction separated by fallow periods and clean seed replanting. The study evaluates two approaches: the first explores the spaces of all possibilities and compares the profit of each deployment strategy while the second utilizes a genetic algorithm which performs better on long time horizons.

Imbalanced Data Classification using Synthetic Minority Oversampling Technique in stages for a Rice Dataset

Moussa Diallo[a], Abdoulaye Sidibé[b], Djibril Diarra[c]

École Normale Supérieure de Bamako, Mali[a], École Nationale d'Ingénieurs Abderhamane Baba Toure, Mali[b], Université des Sciences Sociales et de Gestion de Bamako (USSGB), Institut Universitaire de Développement Territorial (IUDT), Mali[c]

Predicting agricultural production is a very important challenge given global de-mography. However, climate change is one of the factors if not the main key that often skews this agricultural production prediction. Finding a machine learning method to better predict rice production in the Niger River Inner Delta represents an interesting challenge. We use a rice production (Climate-Rice) dataset in this paper. The Climate-Rice dataset is found to be a dataset with a class imbalance problem. In this paper thirty others imbalanced datasets were treated to study the class imbalance phenomenon in a dataset. We also propose a data-level method of solving the class imbalance problem called: Synthetic Minority Oversampling Technique in Stages (SMOTEiS). Our method has been used for Multilayer Per-ceptron (MLP), Logistic Regression (LR) and Support Vector Machine (SVM) classifiers. We compared our method with SMOTE, AdaboostM1, Bagging, CSForest and WiSARD to study its competitiveness. Accuracy being not a good metric for the class imbalance problem, we use three other metrics in this paper such as F-measure, G-mean and MCC (Matthew's Correlation Coefficient). The results of these metrics show that our method is largely competitive with well-known methods for the class imbalance problem in a dataset.

CLUSTER ANALYSIS
(Room 02, Chair person : Pr . . . .)

Functional Sparse Data Clustering using Conditional Expectation PACE Method

Si-Ahmed Idris[a], Azeyou Mazamaesso[a], Hamdad Leila[a], Dabo Sophie[b]

Ecole Nationale Supérieure d'Informatique (ESI)[a], Université de Lille[b]

This article introduces a novel methodology for performing univariate and multivariate functional clus-tering analysis (FCA) on sparse data. The approach aims to address data sparsity by reconstructing missing functional data using the Conditional Expectation (PACE) method. The FCA algorithm uses the EM (Expectation-Maximization) method and incorporates the Bayesian Information Criterion (BIC) for model validation. An application on real functional data is also shown.

Clustering for Performance Optimization in Vehicular Ad-hoc NETworks: A Comprehensive Survey

Siham Hadjout[a], Kahina Ouazine[a], Mohamed Essaid Khanouche[b]

Laboratoire LITAN, École supérieure en Sciences et Technologies de l'Informatique, Algérie[a], Université Claude Bernard Lyon 1, CNRS, France[b]

Vehicular Ad-hoc NETworks (VANETs) are a promising technology for vehicular communications since they enable safer, more efficient, and intelligent transportation systems. However, their highly dynamic topology and intermittent connections present several challenges for reliable information dissemination. Vehicle clustering which groups vehicles into clusters, is an effective approach to improve the perfor-mance and efficiency of VANETs. Several clustering algorithms have been proposed in the past decade to reduce communication overhead, manage topology changes, reduce energy consumption, and provide differentiated quality of service (QoS) levels for different services. This paper provides a new comprehen-sive analysis of recent clustering-based algorithms in VANETs that appeared between 2021 and 2024. These approaches are discussed and compared considering clustering criteria, cluster-head selection met-rics, scalability, performances, and security. Additionally, We deeply examine essential security measures for VANETs, tackling challenges such as multi-layer attacks and leveraging advanced technologies like blockchain to ensure data integrity, confidentiality, and availability. Furthermore, an in-depth and critical analysis of the reviewed approaches is provided to identify gaps and give some future directions.

Hierarchical Sparse Subspace K-Means

Abdoul Wahab Diallo[a], Mory Ouattara[b], François Kaly[c], Ndéye Niang[d]

Dakar Institute of Technology, Sénégal[a], Université de San Pédro, Cote d'Ivoire[b], Université Iba Der THIAM, Sénégal[c], CEDRIC CNAM, Paris, France[d]

In this paper, we discuss clustering methods adapted to high-dimensional data structured in blocks, where the blocks are obtained by grouping the features collected according to specific themes or subspaces of the initial space of features. The proposed approach is based on the Sparse Subspace K-Means (SSKM) method. SSKM is a partition method in the same way as the K-means algorithm, which assigns a sparse weight system to each cluster in the resulting partition. The method is used in a two-level process. The first level consists of applying SSKM to the blocks separately. This provides relevant features for each block. At level 2, SSKM is again applied to the set of features selected at level 1 to determine the final partition of observations and the relevant features that best explain the clusters. The method is evaluated on simulated and real data. The analysis of the results obtained shows that the use of SSKM with two levels produces significantly better results than SSKM with fewer features.

CONTROL, OPTIMIZATION AND STOCHASTIC METHODS 1
(Room 03, Chair person : Pr . . . .)

A Markov Regenerative Stochastic Petri Net for Performance and Reliability analysis of a 3-out-of-$(2 + 2 + 1)$:G Repairable Redundant System

Kheireddine Boudehane[a], Samira Taleb[a]

RIIMA Laboratory, University of Science and Technology Houari Boumediene USTHB, Algeria[a]

The aim of this paper is to study the performance of a K-out-of-$M + W + C : G$ retrial system with a single repairer via a Markov regenerative stochastic Petri net ($MRSPN$). The repairer undergoes preventive maintenance (PM) in idle period. The system is equipped with M primary operating components, W warm standby components, and C cold standby components. The lifetimes of primary components, warm standby components, and preventive maintenance durations are assumed to be exponentially distributed random variables. The repair time of failed components is assumed to be generally distributed. When a component fails, it is either repaired immediately if the repairer is available and free, or it enters a retrial orbit if the repairer is blocked(busy or under PM). We use the $MRSPN$ model to derive the system's main stationary probabilities and some performance reliability measures. Finally, we provide numerical examples to illustrate the effect of system parameters on performance reliability measures.

A classical control-type approach to solve the quasi-newtonian Cauchy-Stokes problem

Marwa OUNI[a], Abderrahmane Habbal[b]

Université de Tunis El Manar, ENIT-LAMSIN, Tunisie[a], Université Côte d'Azur, LJAD, France [b]

The aim of this paper is to study the performance of a K-out-of-$M + W + C : G$ retrial system with a single repairer via a Markov regenerative stochastic Petri net ($MRSPN$). The repairer undergoes preventive maintenance (PM) in idle period. The system is equipped with M primary operating components, W warm standby components, and C cold standby components. The lifetimes of primary components, warm standby components, and preventive maintenance durations are assumed to be exponentially distributed random variables. The repair time of failed components is assumed to be generally distributed. When a component fails, it is either repaired immediately if the repairer is available and free, or it enters a retrial

orbit if the repairer is blocked (busy or under PM). We use the $MRSPN$ model to derive the system's main stationary probabilities and some performance reliability measures. Finally, we provide numerical examples to illustrate the effect of system parameters on performance reliability measures.

2AM FRACTIONAL DYNAMICS FOR EPIDEMIC MODELS 1
(Room 04, Chair person : Pr . . . .)

Fractional dynamics of a new trachoma transmission model

Sylvain Ardo Gouroudja Banbeto[a], Hamadjam Abboubakar [a], Manasse Djouassoum [a,b], Joseph Yves Effa [c]

University of Ngaoundéré, LASE-Lab, Cameroon[a], University of Ngaoundéré, UIT, Cameroon [b], University of Ngaoundéré, Cameroon[c]

The aim of this work is to formulate and analyze a deterministic model for the transmission dynamics of trachoma in Cameroon, in which we take into account direct transmission (human-human), vectorial transmission (human-fly-human), and environmental transmission (human-contaminated objects), using fractional-order derivative in the Caputo sense. After showing the existence and uniqueness of solutions, we compute the basic reproduction number denoted by R_0, and study the stability of the trachoma-free equilibrium point when $R_0 < 1$. We then use the Cameroon data to calibrate the model by estimating certain parameters. We estimate $R_0 = 1.169$, which means that trachoma is endemic in Cameroon because $R_0 > 1$. Numerical simulations are carried out to validate theoretical results.

Fractional dynamics and projection of Tuberculosis in Adamaoua-Cameroon

Manasse Djouassoum[a], Hamadjam Abboubakar [a,b], Sylvain Ardo Banbeto Gouroudja [a], Joseph Yves Effa [c]

University of Ngaoundéré, LASE-Lab, Cameroon[a], University of Ngaoundéré, UIT, Cameroon [b], University of Ngaoundéré, Cameroon[c]

The aim of this work is to formulate and analyze a deterministic model for the transmission dynamics of tuberculosis in the Adamaoua region of Cameroon, in which we take into account both pulmonary and extrapulmonary tuberculosis, and using fractional-order derivative in the Caputo sense. After showing the existence and uniqueness of solutions, we calculate the basic reproduction number R_0, and study the stability of the tuberculosis-free equilibrium point when $R_0 < 1$. Then we show the existence of at least one endemic equilibrium point when $R_0 > 1$. Using data from Adamaoua, we calibrate the model by estimating certain parameters. We thus estimate the value of the basic reproduction number $R_0 = 4.1683$, which means that tuberculosis is endemic in the Adamaoua region since $R_0 > 1$. We then perform numerical simulations to validate the theoretical results.

Fractional dynamics of a Cholera model with Atangana-Baleanu operator

Rubin Fandio[a], Hamadjam Abboubakar[b,c], Sylvain Ardo Banbeto Gouroudja[a], Henri Paul Ekobena Fouda[a,c,d]

University of Yaoundé, BioPhysics-Lab, Cameroon[a], University of Ngaoundéré, Cameroon [b], University of Ngaoundéré, LASE-Lab, Cameroon[c], University of Yaoundé, Cameroon[d]

The goal of this work is to derive and study a Cholera model using fractional-order derivative in the sense of AtanganaâĂŞBaleanu. After the model formulation, we compute the basic reproduction number and perform stability of the disease-free equilibrium whenever the basic reproduction number is less than unity. We then prove existence and uniqueness of solutions. Using Euler scheme, we perform numerical simulations to validate our theoretical results.

INVITED TALK

Ismael Gonzalez Yero
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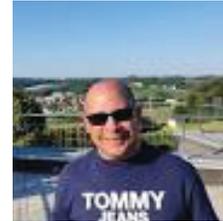
Graph theory and application to social networks

Ismael Gonzalez Yero

Let G be a connected graph. Let $S = \{v_1, \ldots, v_r\} \subset V(G)$ and let $x \in V(G) \backslash S$. The *metric representation* of x with respect to S is the vector $r(x|S) = (d_G(x, v_1), \ldots, d_G(x, v_r))$, where $d_G(a, b)$ is the distance between a, b. The set $S \subset V(G)$ is a *k-antiresolving set* for G, if k is the largest integer such that for all $u \notin S$ there exists a set $S_u \subseteq V(G) \backslash (S \cup \{u\})$ with $|S_u| \geq k - 1$ such that $r(u|S) = r(v|S)$ for every $v \in S_u$. The *k-metric antidimension* of G is the cardinality of a smallest k-antiresolving set for G.

This concept was introduced in [5], and was used to generate a privacy measure of social networks called (k, ℓ)-anonymity. A graph G meets (k, ℓ)-*anonymity* with respect to active attacks to its privacy, if k is the smallest positive integer such that the k-metric antidimension of G is not larger than ℓ. Some extra contributions on this topic can be found in [1, 2, 3, 4].

Several results on the k-metric antidimension of graphs shall be discussed in this talk, emphasizing in some combinatorial properties of the parameter, as well as, computational aspect of it including privacy evaluations of some networks.

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Adversarial Attacks and Defense Mechanisms in Computer Vision: a Comprehensive Survey

Anis Chawki Abbes[a], Nassima Slimani[a], Cherif Ahmed Cherif[a], Siham Hadjout [a], Amine Mammasse [a], Amani Mankouri [a], Sonia Kherbachi [b]

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Adversarial attacks , which craft subtle input perturbations to induce failures in deep neural networks, pose critical threats to deployments of computer vision systems. This paper surveys recent advancements in adversarial attacks targeting computer vision systems across multiple domains, including image classification, object detection, semantic segmentation, and image-to-text models. This survey gives in-depth coverage of state-of-the-art defense strategies proposed recently to counter these attacks. Through rigorous evaluation of recent scholarly articles, this survey provides vital awareness into adversarial threats faced by vision systems and delivers clarity on open research frontiers essential for developing robust computer vision models and systems resilient to real-world attacks. Both problem analysis and defense strategy perspectives are covered in a holistic manner.

Contextual keystroke dynamics for free-text authentication on computers

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University of Dschang, Cameroun [a], University of Buea, Cameroon [b]

We live in a fully networked world, with the ability to access digital information systems anytime, anywhere, using a variety of technological devices. This raises concerns about the security of systems and the protection of users' personal information. To prevent unauthorised use of a system, authentication is used as the first security filter. The login/password pair is the most widely used authentication method in today's information systems. However, the system becomes vulnerable if a third party illegally obtains this information. In addition, the user's identity is only verified during the connection phase of their work session. Keystroke dynamics can be used as an additional layer of security to continuously verify that the person using the system is who they claim to be. In this research, we propose a continuous authentication model based on one-way LSTMs that uses the contextual characteristics of a user's keystroke dynamics. This model gave an accuracy of 96% on the Bufalo keystroke dataset.

ABTM - An attention-based translation model: Case study of Kenya a local Cameroonian language

Lionel Landry Sop Deffo[a], Elie Fute Tagne[ab], Enow Nesta Egbe[a]
University of Buea, Buea, Cameroon[a], University of Dschang, Cameroon[b]

In this study, we propose an attention-based translation model for translating KÉŻnyaÅŃ, an indigenous Cameroonian language to English. We experiment with two different attention mechanisms, Bahdanau attention and Luong at-tention, to enhance the model's ability to align input and output sequences effectively. We compare the performance of the translation model using both attention mechanisms. Our experimental results, evaluated using BLEU score as a metric, indicate that the Bahdanau attention

mechanism outper-forms the Luong attention mechanism in terms of translation accuracy. This enables the model to generate translations that better preserve the meaning and nuances of the original text. The effectiveness of Bahdanau attention underscores its suitability for addressing the challenges inherent in translating between diverse language pairs, contributing to the advancement of machine translation research in multilingual contexts.

A modified remora optimisation for optimal localisation of weather radars network over an airspace

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Aeronautical Sciences Laboratory, Aeronautical and Spatial Studies Institute, Blida 1, Algeria[a], LAMDA-RO, University Saad Dahlab Blida 1, Algeria

The objective of this study is to identify the optimal location for weather radar networks in order to enhance air traffic control (ATM) in adverse conditions. This paper presents MS-ROASMA, a hybrid algorithm combining modified remora optimisation and slime mould algorithms. MS-ROASMA is utilised for the generation of optimal location radar networks (OLRNs) based on digital elevation models. The algorithm employs a discrete approach to spatial solutions, utilising nested optimisation for population diversity and incorporating self-adaptive positioning updates. MS-ROASMA is capable of minimising partial beam blockage (PBB) while simultaneously considering elevation and distance constraints. The findings demonstrate that the modified algorithms outperform the original ones for small populations, thereby providing an effective solution for optimal radar placement under computational constraints.

Enhanced TSCH Protocol for IoT and Industry 4.0 Applications

Touloum Soraya[ab], Louiza Bouallouche-Medjkoune[b], Mohand Moktefi[b], Souhila BRAH[c], Mohamed Bouakazi[c]

ESTIN, Amizour, Bejaia, Algeria[a], LaMOS Research Unit, University of Bejaia, Algeria[b], University of Bejaia, Algeria[c]

The IEEE 802.15.4e standard is widely recognized as the de facto standard for the Internet of Things (IoT), providing a mode specifically tailored for industrial applications known as Time Slotted Channel Hopping (TSCH). This mode ensures greater adaptability to the requirements of industrial IoT applications. In this paper, we propose a radio cell scheduling algorithm based on TSCH (Time Slotted Channel Hopping) and OSCAR (Optimized Scheduling Cell Allocation Algorithm) to minimize energy consumption.
We evaluated the performance of this algorithm by simulating it in the Cooja environment using the Contiki OS operating system. Our simulations demonstrate a significant improvement in latency and Cycle of service compared to baseline performance.

Normalization of quality measures of association rules with respect to equilibrium deviation by a homographic function

Feno Daniel[a], Totohasina André[b], Armand[b]

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The normalization of association rule quality measures with respect to equi-librium deviation using an affine function provides us with a new vision of all rule quality measures. Indeed, most existing rule quality measures in the literature are affine-normalizable with respect to equilibrium deviation, their common normalized being the Ganascia measure. However, some quality measures are not yet affine-normalizable. In this paper, we recall the defini-tion of a quality measure normalized with respect to

equilibrium deviation. We then present our process for normalizing quality measures with respect to equilibrium deviation using a homographic function. We show that normali-zation by homography is stronger than normalization using an affine func-tion. In fact, all normalizable affine quality measures are normalizable hom-ographic, and the converse is not always true.

Early Diabetic Retinopathy Detection with Vision Transformers and Optimized Data Preprocessing

Samira Ait Kaci Azzou[a], Djamila Boukredera[b], Sifedine Baouz[c], Toufik Azzi[c]

LIMED, University of Bejaia, Algeria[a], LMA, University of Bejaia, Algeria[b], Department of Computer Science, University of Bejaia, Algeria[c]

Diabetic Retinopathy (DR) is a severe eye disease affecting diabetics. Early detection is crucial to prevent vision loss. In this paper, we adopt and fine-tune transformer-based learning models to capture the crucial features of retinal images for a more nuanced understanding of DR severity. To improve early detection, we convert a 5-class dataset into 3 clinically relevant stages (no DR, early DR, advanced DR). Our methodology follows a three-stage process: initial preprocessing of images to improve image quality, then feature extraction utilizing the vision transformer model (ViT), and finally classification employing multi layer process to categorize them into three stages of DR. Our experimentation on the APTOS dataset showcases that our improved classification approach employing a ViT model achieves highlevels of accuracy (0.9297) and precision(0.98).

A Low-Resource Language Translation: French To Mooré

Hamed Joseph Ouily[ab], Aminata Sabané[ab], Delwende Eliane Birba[c], Rodrique Kafando[a], Abdoul-Kader Kabore[a], Tégawendé F. Bissyandé[ab]

Centre d'Excellence CITADEL, Université Virtuelle du Burkina Faso[a], Département d'Informatique, UFR/SEA, Université Joseph KI-ZERBO[b], AI-KING GROUP[c]

Natural Language Processing (NLP) is an exciting field of artificial intelligence with the goal of enabling machines to understand human language in a natural way. Neural Machine Translation (NMT) stands out as one of the most promising applications of NLP, offering the ability to effectively translate text from a source language to a target language. In recent years, NMT has experienced significant advances, marking a major milestone in the development of automatic translation systems. Through the use of neural networks, NMT has demonstrated an ability to capture the nuances of language, thereby improving the quality of translations and making the experience of multilingual communication more seamless and precise. This evolution has opened new perspectives in areas such as international collaboration, inter-cultural understanding, and the global dissemination of information. However, most African languages, especially those in Burkina Faso, have received very little research attention in this context. In this paper, we propose a model for machine translation from French to Mooré using Transformer architectures. We obtained a BLEU score of 71.18, which is an important step towards facilitating linguistic inclusion and communication for under-represented languages.

A Hybrid Model Based on State-ANFIS And Particle Swarm Optimization Algorithm For Short-term Load Forecasting

Franck-steve Kamdem-Kengne[a], Mathurin Soh [a], Celestin Lele [a]

University of Dschang, Dschang, Cameroon [a]

Load consumption forecasting plays a crucial role for power systems operators to ensure reliable and efficient operation. Traditional load forecasting methods, such as time series analysis and regression, have been shown to be inadequate for capturing the complex dynamics of load consumption. In this paper, we propose a novel approach for short-term load forecasting by hybridizing a state-ANFIS (SANFIS) model with particle swarm optimization algorithm (PSO). The hybrid model set up contains 5 layers : fuzzyfication layer, rule layer, normalization layer, consequence layer and output layer for a total of 120 parameters to be determined during training using the PSO algortihm instead of gradient descent. Multivariate time series data from the city of Johor in Malaysia generated in 2009 and 2010, which include hourly load data and hourly temperature time series were used to feed in the SANFIS model in order to determine using the PSO algorithm good values of parameters that minimize forecasting errors made by the models. We evaluated the proposed approach on an unsed part of load consumption of the city of Johor in Malaysia dataset. The results show that the proposed approach can significantly improve the accuracy of load forecasting by obtaining a root mean squared error of 0.000648 and a mean absolute percentage error of 0.043 while using the whole dataset.

Deep Neural Networks Architectures for Methane Emissions Predictions - Case Study of Algeria

Widad Hassina Belkadi[a], Yassine Drias[b], Habiba Drias [a], Sarah Ferkous [c], Maroua Khemissi [c]

LRIA, USTHB, Algeria[a], MEF University, Istanbul, Turkey

Methane (CH_4), a potent greenhouse gas with a higher Global Warming Potential (GWP) than carbon dioxide (CO_2), significantly impacts the global climate system. This paper presents novel CNN-LSTM and CNN-GRU architectures for predicting methane emissions. We evaluate and compare deep learning models, including LSTM, GRU, CNN-LSTM, and CNN-GRU, using Sentinel-5P data from the Copernicus project extracted via Google Earth Engine. Performance metrics such as MAE, MSE, RMSE, and R-squared are rigorously assessed to determine model efficacy across Algeria. Algeria was selected due to its hydrocarbon-dependent economy, where mitigating emissions is crucial for sustainable development. Our findings offer insights into model performance and provide recommendations for future research, including the integration of supplementary data, expansion of training datasets, enhancement of spatial resolution, and exploration of advanced architectures. This research has significant implications for informing policy decisions and implementing targeted strategies to combat climate change.

Integro-differential Model of Control Maize Pests by Pesticides

Blériot Stéphane Tchienkou Tchiengang[a], Valaire Yatat Djeumen[b,c], Jean Jules Tewa[b,d]

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In this paper, a modelling the infestation of maize by maize stem borers *Busseola fusca* is done considering a pesticide-based chemical control method. Chemical control involves applying pesticides to maize plants in order to destroy the larvae present. The modelling takes into account key factors such as the effect of the pesticide on the pests (considered as excess larval mortality), the pest resistance (a consequence of pesticide use) and the fitness costs of pests associated with resistance. We obtain an integro-differential model that captures the dynamics of quantitative resistance, by treating resistance as a continuous variable ranging from total sensitivity to total resistance. Our results highlight not only the essential role played by pesticide use on the pest population but also the importance of pesticide dosage in the success of chemical control. We also show that the outcome (success or failure) of chemical control may depend of some parameters such as the intrinsic eggs-laying of pests (adult females).

Linear Control Law for Fractional-order Degn-Harrison System Synchronization

Naziha Belmahi[a], Fatiha Mesdoui[b]

Department of Mathematics, University of Sciences and Technology Mohammed Boudiaf, Oran, Algeria[a], LAOTI Laboratory and Department of Mathematics, Mohamed Seddik Ben Yahia University, Jijel, Algeria[a]

This study explores the application of fractional calculus in enhancing the dynamics of differential system models, focusing on the time–fractional version of the Degn-Harrison model. By employing a linear controller, global synchronization of the model is achieved, showcasing the efficacy of fractional calculus in control theory. The findings are validated through numerical simulations, providing empirical evidence for the proposed approach's effectiveness in understanding and manipulating complex dynamical systems.

Theoretical explanations and stability analysis of higher-order difference equations linked to generalized Balancing numbers

Yacine Halim[a],[b]

Abdelhafid Boussouf University of Mila, Algeria[a], LMAM Laboratory, Mohamed Seddik Ben Yahia University of Jijel, Algeria[b]

We put forth theoretical explanations concerning the representation of solutions for higher-order difference equations, where the solution is linked to generalized Balancing numbers. Additionally, we investigate the stability characteristics and asymptotic behavior of this equation.

Complexities of a two-dimensional discrete fractional-order system: Chaos and synchronisation

Hadjabi Fatima[a], Mesdoui Fatiha[b]

Department of Sciences and Techniques, University of Larbi Ben M'Hidi, Oum El Bouagui, Algeria[a], Department of Mathematics, University of Jijel, Algeria[b]

In order to establish chaos synchronisation with other chaotic maps, we generalize, in this study, an integer-order system proposed in 1995 to introduce a new fractional-order map. Using phase portrait, and bifurcation diagram, we establish the occurrence of chaos. The study then suggests a linear controller in order to bring two fractional-order systems into linear synchronisation. The one-dimensional and linear nature of the developed controller makes them affordable and simple to use.

Optimization of a fractional proportional integral derivative (PID) controller using genetic algorithms (GA) to improve the performance of a fractional system

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Electrical Engineering Department, University of Bouira, Algeria[a], LISEA, University of Bouira, Algeria[a]

A new wave of curiosity has recently focused on fractional calculus, a branch of mathematics concerned with integrals and derivatives of non-integer order. Control theory, signal processing, engineering, and physics are just a few of the areas that have benefited from its use. New control algorithms and methods have been developed thanks to the application of fractional calculus in control theory. These methods and algorithms offer advantages when dealing with complicated and non-linear systems. By incorporating a fractional order integrator and differentiator into the classical feedback adaptive PID controller, this

study demonstrates how to optimize a fractional adaptive PID controller using a genetic algorithm to enhance aircraft performance in four key areas: rise time, setting time, overshoot, and mean absolute error. Research comparing the classical adaptive PID controller to the suggested genetic algorithm-optimized fractional-order adaptive PID controller has been conducted in order to substantiate the claims. In order to confirm the optimal controller, numerical simulations and analyses are provided. When comparing settling time, rising time, overshoot, and mean absolute error, the fractional order adaptive PID performs the best. To enhance the performance and noise rejection of various fractional and integer systems, this approach can also be applied generally.

Rounding Heuristic for Integer Linear Programs

Abdelkrim Rezzag[a], Mohand Ouamer Bibi[a], Hacène Ouzia[b]

Research Unit LaMOS, University of Bejaia, Algeria[a], LIP6, Sorbonne universite, CNRS, Paris, France[b]

In this work, we propose a new heuristic aimed at finding feasible solutions for bounded integer linear programming problems with a positive constraint matrix and right-hand side. The heuristic involves bound reduction and rounding using an auxiliary problem. Both the bound reduction and rounding steps rely on the optimal solution of the continuous relaxation. The efficiency of the proposed heuristic, in terms of execution time and solution accuracy, is demonstrated through numerical experiments.

An initialization technique for the dual support method of linear programming with nonnegative variables

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Laboratory of Pure and Applied Mathematics, University of Laghouat, Algeria[a], LaMOS Research Unit, University of Bejaia, Algeria[b]

The dual support method is developed by Gabasov and Kirillova for solving Linear Programming (LP) Problems with finite-bounded variables. In this work, we present a version of the dual support method for solving LP problems with nonnegative variables. In order to initialize this algorithm, we propose a technique for finding a dual feasible solution, then we present a numerical example to illustrate the proposed approach.

Method for solving a fractional linear problem with bounded variables

Nassima Lazari[a], Mohand Ouamer Bibi[a]

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In this work, we propose a method for solving fractional linear programming problems with bounded variables, based on the concept of the adaptive method with a hybrid direction. In addition, we define a quantity called the optimality estimate, from which we deduce a necessary and sufficient condition for optimality.

Exploration of Heuristic Methods for Solving Multi-Objective Stochastic Traveling Salesman Problem

Thiziri Sifaoui[ab], Méziane Aider[cd]

Department of Mathematics and Computer Science, University of Tamanghassat, Algeria[a], LAROMAD, University of Tizi Ouzou, Algeria[b], LaROMaD, USTHB, Algeria[c], UPJV, EPROAD UR 4669, Amiens, France[d]

This paper addresses the Multi-Objective Stochastic Traveling Salesman Problem (MO-STSP), where travel distances and times are modeled as stochastic variables following a uniform distribution. To manage the inherent uncertainty, the problem is first transformed into a deterministic form using the expected values of these stochastic parameters. Subsequently, heuristic methods are applied to solve the deterministic version. Specifically, two approaches are proposed: the 2-Opt local search algorithm, which iteratively refines local solutions through edge rearrangement, and Monte Carlo simulations, which explore the solution space via random sampling. Both methods were selected for their effectiveness in managing the complexities and uncertainties associated with the MO-STSP. Implemented in Python and tested on random instances, these methods provide robust solutions that balance travel distance and time. The study includes a comparative analysis of the two heuristics, highlighting their strengths and trade-offs, and suggests practical applications in logistics and transportation. This research contributes to the field of stochastic optimization by demonstrating the effectiveness of using expected values and heuristic techniques to address the MO-STSP and proposes future research directions, including the integration of advanced metaheuristics.

Modelling the Rhythmic Structure of Traditional Gurna Music using Merged-output Hidden Markov Models

Patrick Dabou Nounamo[a],[b], Rémy Maxime Mbala[c], Fritz Mbounja Besseme[c], David Libouga Li Gwet[c], Emile Ronwe Manhouli[b], Kolyang[a],[b]

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This document presents a study on Gurna, a traditional music form from Cameroon and Chad, with a focus on its rhythmic structure. It uses merged-output Hidden Markov Models (HMM) to model the complex polyrhythmic and polyphonic nature of this music. The challenge stems from the irregular bar lengths and the interplay of multiple voices, making it difficult for conventional transcription tools to handle. The study proposes a statistical model that merges outputs of multiple sound sources and uses the Viterbi algorithm to infer rhythms. The results show promising accuracy in transcribing Gurna's unique rhythm with a rate of 80.2%, which is significant for preserving this African musical heritage.

Adaptive Refined Descriptive Sampling Algorithm for Dependent variables using Iman and Conover method in Monte Carlo simulation

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Applied Mathematics Laboratory, University of Bejaia, Algeria[a], Applied Mathematics Laboratory, University of Tipaza, Algeria [b]

We propose an algorithm to generate refined descriptive samples from dependent random variables for estimation of expectations of functions of output variables using the Iman and Conover algorithm to transform the dependent variables to independent ones. Hence, the asymptotic variance of such an estimate in case of dependent input random variables is proved, using a result from to be less than that obtained using simple random sampling.

17ᵉ

Concert du 17ᵉ anniversaire du CARI'2024 avec l'Orchestre de Ahbab Cheikh Sadek El Bedjaoui
(Andalou, Kabyle, Chaabi, ...)

Les élèves de l'école

Maison de la Culture Aamriw, Béjaïa
Dimanche 24 Novembre 2024 à 18 heures 30mn

INVITED TALK

Farouk Toumani
Professeur en Informatique
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Ontology-mediated query answering and beyond
Farouk Toumani

The framework of ontology-mediated query answering (OMQA) enhances data retrieval and interpretation by integrating ontologies with traditional query mechanisms. Ontologies provide a structured, semantic layer that describes the relationships and properties of concepts within a domain, enabling more precise and meaningful query results. This talk will delve into OMQA, highlighting its foundational principles, main approaches, and significant results. Beyond traditional first-order queries, we will address the challenge of structural queries (a kind of meta queries), which involve extracting detailed information about the properties of individuals and concepts within a knowledge base. Additionally, the talk will introduce the emerging field of neuro-symbolic reasoning, which combines symbolic logic with neural networks to enhance both symbolic and sub-symbolic reasoning, showcasing recent advancements and potential applications.

5CS Optimization and Heuristics 2

A DSL for Dynamic Programming: Generating Sequential Code

Rivaldes Tiyo Melong[a], Jerry Lacmou Zeutouo[a], Milliam Maxime Zekeng Ndadji[a], Maurice Tchoupé Tchendji[a]

University of Dschang, Cameroon[a], Team Avalon INRIA, LIP, ENS-Lyon, France[b]

The aim of this paper is to study the performance of a K-out-of-$M + W + C : G$ retrial system with a single repairer via a Markov regenerative stochastic Petri net ($MRSPN$). The repairer undergoes preventive maintenance (PM) in idle period. The system is equipped with M primary operating components, W warm standby components, and C cold standby components. The lifetimes of primary components, warm standby components, and preventive maintenance durations are assumed to be exponentially distributed random variables. The repair time of failed components is assumed to be generally distributed. When a component fails, it is either repaired immediately if the repairer is available and free, or it enters a retrial orbit if the repairer is blocked(busy or under PM). We use the $MRSPN$ model to derive the system's main stationary probabilities and some performance reliability measures. Finally, we provide numerical examples to illustrate the effect of system parameters on performance reliability measures.

Modelling Behavior of Microbiota Metabolic Network Subject to Diets

Oumarou Abdou ARBI[a], Jérémie Bourdon[b], Anne Siegel[c]

Université Dan Dicko Dankouloudo de Maradi, Niger[a], Ecole Centrale Nantes, CNRS, LS2N, UMR 6004, France[b], Université de Rennes, Inria, CNRS, IRISA UMR 6074, france[c]

The study of the gut microbiota has sparked a lot of interest in recent years because understanding its composition and function enables us to assess the health status of its host and helps prevent certain diseases. It is primarily composed of bacteria. The metabolic networks of the various identified bacteria in the microbiota have been reconstructed. The metabolic network is defined as the set of biochemical reactions that can take place within an organism, as well as the exchanges of metabolites between the organism and its environment. Across numerous organisms, efforts have been made to reconstruct this network, employing manual or automated processes. These comprehensive networks are stored in biological reference databases. One such database is the Virtual Metabolic Human, a repository housing all identified bacterial networks derived from studies on intestinal microbiota. These networks serve as a foundation for modeling organism behavior under specific dietary conditions. Our focus in this study involved employing Flux Balance Analysis on the 818 bacterial networks cataloged in the Virtual Human Metabolic database, exploring their responses across 11 distinct diets. The results of this statistical analysis revealed an intriguing trend: the bacteria primarily gravitated towards four specific diets, showcasing the highest values in biomass maximization. Notably, certain bacteria displayed considerable variability in their biomass maximization results across different diets. Moreover, the statistical analysis highlighted a strong correlation within certain bacterial families concerning the import/export dynamics of nutrients across varying dietary conditions. This sheds light on the nuanced relationship between bacterial responses and dietary compositions, offering valuable insights into their metabolic adaptability.

Improved photometric stereo based on Bee Swarm Optimization BSO algorithm

Aimen Said Mezabiat[a], Lyes Abada[a] and Tarek Gacem[a]

University of Sciences and Technology (USTHB), Artifcial Intelligence Laboratory (LRIA), Algeria[a]

Despite advancements in computer vision, reconstructing 3D structures from 2D images (3D reconstruction) remains a challenge. This technique, tackling the inverse problem of image formation, aims to recover the lost dimension by creating a 3D object model from images. Shape from Shading (SFS)is a common method that suffers from limitations. Photometric Stereo (PS) offers a more general approach for 3D reconstruction, paving the way for our proposed method based on the BSO algorithm.

GPU-based Support Vector Machine using Artificial Orca Algorithm for Intrusion Detection Systems

Lydia Sonia Bendimerad[a], Habiba Drias[a] and Naila Aziza Houacine [a]

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Nowadays, computer networks serve as the foundation for many systems. As a result, they become exposed to attackers who may use them to obtain unauthorized access. And unfortunately, the variety of attacks makes classic systems unable to deal with all malicious traffics. Swarm Intelligence algorithms prove their effectiveness in solving several problems, even when time is a constrained, it can be adapted to GPUs to improve their efficiency. This paper proposes an interesting application of a novel swarm intelligence algorithm known as the Artificial Orca algorithm (AOA) to deal with detecting intrusions incoming in a system. The problem is called Intrusion Detection System, and the AOA is proposed as an optimization algorithm for Support Vector Machine (SVM-AOA) to classify traffic. Unlike the existing literature, this paper integrates GPU architecture to parallelize the AOA algorithm (GPU-SVM-AOA). To come out with the best/near-best parameters of the SVM model, the proposed methods have been subject to the NSL-KDD dataset, and several experiments were conducted under C++ and Cuda programming languages using the OpenCV library for the machine learning model. The outcomes show that the RBF function is the best kernel function for the NSL-KDD dataset. Comparing SVM-AOA and GPU-SVM-AOA with state-of-the-art methods, namely SVM-Particle Swarm Optimization, K-Nearest-Neighbor, and decision tree, show that the present contributions outperform especially GPU-SVM-AOA. In addition to being comparable to SVM-AOA in terms of accuracy, recall and fitness value, GPU-SVM-AOA also improves the running time.

6CS Reactive Systems
(Room 02, Chair person : Pr . . . .)

Expressiveness of the LSAWfP Workflow Language Compared to BPMN

Marionne Daniela Nguedia Momo[a], Milliam Maxime Zekeng Ndadji[a], Maurice Tchoupe Tchendji[a], Franck Bruno Tonle Noumbo[a,b]

University of Dschang, Cameroon[a], International Centre of Insect Physiology and Ecology (ICIPE), Kenya[b]

Business processes modeling typically faces challenges in the integrated representation of processes' lifecycle, informational, and organizational models. Despite the plethora of process modeling languages (workflow languages), studies on their expressiveness fail to identify a consensus on the languages and techniques to use. Consequently, some languages like LSAWfP, brimming with new techniques, continue to be proposed. LSAWfP relies on attributed context-free grammars to offer another perspective on

process modeling with the goal of their decentralized execution. Preliminary studies on the expressiveness of LSAWfP demonstrate its support for process modeling cases generally supported by commercial solutions. However, these studies are insufficient as they only explore a small facet of LSAWfP's expressiveness. This paper delves deeper into the expressiveness of LSAWfP by comparing it to the BPMN language, a domain standard. The comparative analysis between these two languages in this paper is conducted along three dimensions: control flow, data integration, and organizational structure. To leverage the theoretical studies in this paper, a foundation for a tool converting LSAWfP specifications into BPMN models is also proposed. The results of all these efforts further demonstrate that LSAWfP is a solution with significant operational and commercial potential.

A Service Composition Engine for Incremental Computation

Joskel Ngoufo Tagueu[a], Adrián Puerto Aubel[a], Maurice Tchoupe Tchendji[a,b]

University of Dschang, Cameroon[a]

We present a service composition engine that allows for distributed incremental computations. Services have become a standard of remote computing. They are hardware and software resources that can be used regardless of their implementations. When requesting a service, one must provide all the parameters, and data needed for the service to be performed. Service orchestrators, such as kubernetes, are tools that provide an automatic handling of the distribution and scalability of services, for efficient resource allocation. We introduce a prototype based on a formal model of distributed computation: Guarded Attribute Grammars. It is built on top of kubernetes so as to exploit all the features of the orchestrator, and allows for describing services as composed of other services and local computations. This is done through a descriptive programming language whose instructions are interpreted as co-routines, and allows for a flexible data flow: if only part of the data is available, the co-routines that do not rely on the missing part can start their execution. Recursively, such a service starts as soon as some of its co-routine components can start computation, and returns each of its output values as soon as it is available. Guards allow for alternative descriptions of the same service, depending on what data is available, or its nature, which provides full expressiveness to our programming language.

Addressing Input/Output composition through Open Automata representation

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LTCI, Télécom Paris, Institut Polytechnique de Paris, France[a]

Compositional design is a highly convenient approach for specifying and verifying large-scale systems, particularly distributed systems. Automata are widely employed as the basic formalism in this approach. These systems, which are state machines, allow for modelling individual components, their interactions, and their behaviours, but also provide standard modelling methods such as parallel composition and levels of abstraction. In this paper, we focus on distributed systems composed of reactive components. We will examine a new formalism that builds upon existing formalisms, allowing for the modelling of the components and their interactions. The aim of this formalism is to provide a theoretical tool for reasoning about behavioural equivalence among reactive systems.

Formal Verification of Deep Learning Matrix Calculus

Razika Lounas[a], Mezghiche Mohamed[a]

LIMOSE laboratory, University Mohamed Bougara of Boumerdes, Algeria[a]

Nowadays, deep learning applications are utilized across various critical domains such as healthcare systems, industrial control, and automated driving. The incorporation of deep learning applications into such critical contexts has sparked interest in their formal verification, necessitated by the high level of rigor demanded by these applications. This paper introduces a formal verification approach at the source code level for matrix operations, which are extensively employed by deep learning applications using the Frama-C platform. These operations are derived from the BLAS (Basic Linear Algebra Subroutines) scientific library. The formal verification process begins with the specification of the program using an annotation language in the style of Hoare logic, facilitated by the platform. A set of verification conditions is then generated based on the specified program. These verification conditions are subsequently discharged using the Coq proof assistant. The primary objective of this article is to bolster confidence in deep learning operations by demonstrating the verification of properties through logical models of memory, data structures, and operations.

5AM PREDATOR - PREY SYSTEMS 2
(Room 03, Chair person : Pr . . . .)

Global dynamics of a SEIRD-B epidemic model with convex incidences

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In this work, we extend a classical SEIR epidemic compartmental model by including convex incidences rates, dead and pathogen classes. After the model formulation, we compute the basic reproduction number $\mathcal{R}_0$ and prove the local and conditionally global stability of the disease-free equilibrium whenever $\mathcal{R}_0 < 1$. For $\mathcal{R}_0 > 1$, we prove existence of a unique endemic equilibrium, as well as the global stability under conditions. Theoretical results are illustrated through numerical simulations. Then, the model is calibrated using Ebola data in Guinea. Indeed, we performed parameter estimation which permitted to obtain the value of the basic reproduction number $\mathcal{R}_0 = 42.95$. Finally, we perform simulations to validate theoretical results.

A model of plasmid-bearing, plasmid-free competition in a chemostat

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ITAP, Univ Montpellier, INRAE, Institut Agro, France[a], Ibn Khaldoun University, Tiaret, Algeria[b], Djillali Liabès University, Sidi Bel Abbès, Algeria[c]

In this paper we consider a competition model between plasmid-bearing and plasmid-free organisms in a chemostat that incorporates both general response functions, distinct yields and distinct removal rates. The model with identical removal rates and identical yields was studied in the existing literature. The object of this paper is to provide the local analysis of the model in the case of different removal rates and distinct yields. In this case the conservation law fails. The operating diagram giving the asymptotic behaviour of the model with respect of the operating parameters is also presented.

On a slow-fast SEIRS Model structured in age

Radhwane Benkhaled[a], Karim Yadi[a]

Aboubekr Belakaid University, Tlemcen, Algeria[a]

A singularly perturbed model emerges when we combine a SEIRS epidemiological model whose time scale is the day, with a juvenile/adult demographic model whose time scale is the year. In this article, the combined model is used to describe the dynamics of the corona virus COVID-19, taking into account the rhythm of the start of this epidemic, which seemed to affect only adults. The 5 dimension model is reduced, by applying Tikhonov's Theorem for slow-fast systems, to a linear or affine planar model, depending on the initial conditions, whose solutions provide an approximation of the initial solutions in their slow phases, for arbitrarily large times.

Global asymptotic stability for a predator-prey model

Amina HAMMOUM[a], Karim YADI[a]

Aboubekr Belkaid University, Tlemcen, Algeria[a]

The main objective of this paper is the study of the global asymptotic stability of an interior equilibrium for a general prey-predator model with a variable mortality rate. Knowing the local asymptotic stability conditions, we give various other conditions for globality, using Lyapunov's direct method or showing the non-existence of limit cycles by Dulac's criterion. We also provide applications for specific models.

6AM PARTIAL DIFFERENTIAL EQUATIONS MODELING
(Room 04, Chair person : Pr . . . .)

Traveling wave and critical wave speed in a nonlocal dispersal Eire-mediated tree-grass interactions system in humid tropical savannas

Simon Rodrigue Tega II[a,b,c], Ivric Valaire Yatat-Djeumen[a,c], Jean Jules Tewa[a,b], Pierre Couteron[a,c,d]

University of Yaoundé 1, Cameroun[a], IRD/UPMC UMMISCO, Bondy, France[b], AMAP, Univ Montpellier, CIRAD,CNRS,INRAE,IRD, France[c], International Joint Laboratory DYCOFAC, IRD-UYI-IRGM, Yaoundé, Cameroun[d]

Being able to predict the different transitions of vegetation mosaics in humid environments is one of the main objectives in the study of vegetation dynamics. This work attempts to model the capacity of the forest in humid tropical ecosystems, to replace grassland in landscape mosaics if no appropriate management plan is implemented. We build in one spatial dimension, a reaction-dispersion model with nonlocal dispersion and we study the long-term dynamics of forest-grassland mosaic by the mean of the traveling wave solution setting. Precisely, we prove the existence of a traveling wave that connects the forest homogeneous steady state to the grassland homogeneous steady state. We also characterize the minimal wave speed of the aforementioned forest-grassland traveling wave. Moreover, we provide numerical simulations that depict how some parameters of the model may shape variations of the minimal speed.

Traveling Profile Solutions for Parabolic Equations Describing Diffusion Phenomena

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This paper aims to investigate and derive new exact solutions for a degenerate parabolic partial differential equation, specifically a nonlinear diffusion equation that is not in divergence form. We propose an approach inspired by the traveling profile method to obtain a general form of self-similar solutions to this equation. The behavior of these solutions depends on certain parameters, which determine whether their existence is global or local in a given time T.

Positive solutions for elliptic problems with critical Hardy-Sobolev exponent and singular weight

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Laboratoire Systèmes Dynamiques et Applications (SDA), University of Tlemcen, Algeria[a]

Let $\Omega \subset \mathbb{R}^N$ be a smooth bounded domain with $0 \in \Omega$, $N \geq 3$, $0 \leq s < 2$, and define the critical Hardy-Sobolev exponent by $2^*(s) \triangleq \frac{2(N-s)}{N-2}$. In this paper, We establish the existence of positive weak solutions of the singular critical problem

$$-\Delta u - \mu \frac{u}{|x|^2} = \frac{|u|^{2^*(s)-2}u}{|x|^s} + \lambda f(x)u$$

with Dirichlet boundary conditions on Ω, where λ and μ are positive parameters.

Solving of the anti-plane problem of elasticity for an infinite strip weakened by a crack

Nikolay Zaitsev[a], Zinaida Zhuravlova[a]

Mechnikov National University, Ukraine [a]

Anti-plane problems of elasticity theory occupy an important place in the mechanics of deformable solids, which is connected with their role in modeling of various engineering problems. This work is devoted to solving of the anti-plane problem of the elasticity theory for a strip weakened by a crack, the construction of an analytical solution of the problem through the application of the integral Fourier transform, the reduction of the original problem to one-dimensional problem and by its solving through the Green's function. The final results are derived by the solving of the singular integral equation by the orthogonal polynomials method. The numerical solution of the problem consists in the application of reduction method and deriving the unknown jump function in the form of a series of Tchebychev polynomials. The study of displacements and stresses is made through the construction of graphic calculations for the area and the calculation of stress intensity factors for this problem under specified loads and for specific parameters of materials and crack locations.

7CS KNOWLEDGE DISCOVERY, NATURAL LANGUAGE AND SPEECH PROCESSING
(Room 01, Chair person : Pr . . . .)

A low-ressource language dataset: Moore Natural Emotions Speech Dataset

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Université Nazi BONI, Laboratoire d'algèbre, de Mathématiques discrètes et d'Informatique,
Bobo-Dioulasso, Burkina Faso[a]

Given the immense importance of emotions in human relationships, many researchers have been interested in setting up systems for emotion recognition through speech. These systems provide applications that have a positive impacts on human life. Emotion recognition systems are based on computer science techniques, but fundamental studies on emotions are done by psychologists, who have shown that emotions differ from one society to another. Taking into account these variations, and to enable the construction of systems that can properly recognize emotion in Moore language, we have built the first speech emotional dataset in this language namely Moore Natural Emotions Speech Dataset(MNESD). This is a fundamental step in the implementation of these recognition systems. The corpus contains 6017

audio files on natural emotions collected from the public radio of Burkina Faso. It covers 7 emotions (joy, satisfaction, neutral, anger, contempt, disappointment and sadness). Through this study, we aim to encourage studies on speech emotions recognition in African societies by making available a speech corpus in Moore. We carried out the first experimentations with MNESD combining Mel Frequency Cepstral Coefficients(MFCC) and Fundamental Frequency(F0) coefficients. The best accuracy obtained is 90% using LSTM classifier. The dataset is available on Kaggle, and the link is provided at the conclusion of this paper.

Automatic pure speech files detection using MFCC+F0 features and LSTM classifier in multilingual context for low-resource languages

Go Issa Traoré[a], Borlli Michel Jonas Some[a]

Université Nazi BONI, Laboratoire d'algèbre, de Mathématiques discrètes et d'Informatique, Bobo-Dioulasso, Burkina Faso[a]

This paper focuses on the creation of a model for distinguishing clean speech (speech without music, interaction or background sounds) from speech containing noise. This model can be used to exploit several speech recognition models such as: automatic emotion recognition models, speaker recognition models, language recognition models, etc. These models are usually trained on data sets containing short-length files. To be useful, these models need to be used in real-world environments where we use voice recordings of several minutes or hours in length which often contain noise. Keeping these noise will lead to false predictions from the model. It is therefore important to be able to automatically distinguish pure speech files from noisy files in order to provide the model with good files. Our contribution in this paper is twofold. Firstly, we are making available to the scientific community a dataset of around 15.21 hours of speech containing clean utterances and noisy utterances. Three languages are considered in this paper: Moore, Dioula and Fulfulde. The second contribution concerns the pure speech detection model, which is useful for exploiting other speech recognition models. The combination of MFCC+F0 extractor is used to have speech characteristics and the LSTM is applied as a deep learning algorithm to classify audio into "noise" and "no noise" classes. Evaluation of this model gives an accuracy of 97.62%.

Benchmark Analysis of Time Series Models for Malaria Trends in the Adamawa Region (Cameroon)

Apollinaire Batoure Bamana[a], Yannick Sokdou Bila Lamou[a], Alioum Abdoulaye[b]

University Institute of Technology, Ngaoundere, Cameroon[a], National Advanced School of Engineering, University of Maroua, Cameroun[b]

Malaria remains a major infectious disease that causes a great deal of damage, mainly in African countries. The aim of this work is to assess the dynamics of malaria in the Adamawa Region of Cameroon using time series approaches. This will serve as baseline for further improvement. To this end, data malaria on cases occurring between 2018 and 2022, collected weekly in the form of time series are used. After collecting the data and built up the dataset, the data has been first statistically described. Second, time series analysis is carried out on the dataset. Finally, forecasting is performed using selected basic models, along with a comparison of prediction accuracy metrics. For forecast, a statistical, a machine learning, a deep learning models are used, in addition with a built-up tool. They are ARIMA, RFR, LSTM and Facebook Prophet. Evaluation metrics involved in the benchmark analysis are MAE, RMSE and R2. Random Forest Regressor (RFR) gives the best scores in training for the three metrics, while LSTM gives the best in testing likewise. These prediction models result and data used will serve as benchmarks for the development of more elaborate and precise models, aimed ultimately at producing factual elements for decision support in rolling back Malaria.

HW/SW Co-design Implementation of Elliptic Curve Digital Signature Algorithm for Blockchain Network

Nesrine Guenfoud[a], Mohamed Issad[b], Mohamed Debyeche[a]

Université des Sciences et Technologie Houari Boumediene, Algeria[a], Centre de Développement des Technologies Avancées, CDTA, Algérie

[b]   The Elliptic Curve Digital Signature Algorithm (ECDSA) is one of the most critical entities in the BlockChain (BC) network. This paper presents the Field Programmable Gate Array (FPGA) implementation of the ECDSA protocol for data transactions in the BC network. The ECDSA protocol is based on: (i) a True Random Number Generator (TRNG), (ii) a Scalar Multiplication (SM), and (iii) a Hash function. The execution of the SM algorithm is an iterative process. At each iteration, the following arithmetic operations are performed over a finite field F_p : Modular Addition (MA), Modular Subtraction (MS), Modular Multipli-cation (MM), and Modular Inversion (MI).
In this work, we propose the imple-mentation of the ECDSA using the HardWare/SoftWare (HW/SW) combination. The processor MicroBlaze (MB) is used for the flexibility. Since the MI operation is complex, the Jacobian projective coordinates system is used to overcome this operation. HW part of the proposed embedded system includes the accelerator cores MM, MI, Secure Hash Algorithm (SHA-256), and the TRNG. The controls of the ECDSA and SM as well as the computation of the MA and MS, are exe-cuted in SW by MB. The implementation results show that the execution times of 256-bit ECDSA signature and verification are 75 ms and 149 ms, respectively.

Intrusion recognition coupled with a heuristic attributes selection method using neural networks

Djionang Lekagning Berlin Hervé[a], Tindo Gilbert[a], and Atsa Etoundi Roger[a]

University of Yaounde I, Cameroun[a]

Networks intrusion detection systems allow to detect the various attacks. The problem of precision and flexibility makes IDS inefficient. One of the major reasons of such a situation is the misconception of a correct profile. In this paper, a modular architecture is proposed. This architecture is applied to neural models without attribute selection (MAMuM), with selection (MAMuMS) and in deep learning (MAMuMD). Each module is dedicated to detecting a particular type of attack. To improve those systems performances, it is necessary to select the most relevant attribute that will lead to characterize a normal profile or an attack. We have proposed in this paper an intrusion detection system architecture based classification and coupled with to flexibly select attributes using neural networks. We present a new model of attack type choice. We explain some type of attack. We have done a comparative study with others works. The benchmark dataset NSL-KDD and UNSW-NB15 has been used to train, test and evaluate our work. Our architecture coupled with selection and deep learning improves the accuracy of the intrusion detection. We obtained an average detection rate of 97.3% for the NSL dataset and 92.9% for the UNSW dataset.

7AM Fractional Dynamics for Epidemic Models 2
(Room 03, Chair person : Pr . . . .)

Linear Control Design for Synchronization of Fractional Predator-Prey Systems with Group Defense and Harvesting

Fatiha Mesdoui[a] and Naziha Belmahi[b]

LAOTI Laboratory, Mohamed Seddik Ben Yahia University, Algeria[a], University of Sciences and Technology Mohammed Boudiaf, Algeria[b]

The predator-prey equations are widely used to model the complex dynamics of interacting species in ecological systems. This paper investigates the synchronization of coupled Caputo fractional-order predator-prey equations, incorporating group defense mechanisms and Michaelis-Menten type harvesting to enhance the model's realism. We design a linear controller to facilitate synchronization, offering advantages in cost and simplicity. A suitable Lyapunov fonction is employed to analyze the stability of the error system. Numerical simulations demonstrate the applicability of the proposed synchronization scheme. This investigation provides valuable insights into the synchronization dynamics of ecological networks and their potential management implications.

Fractional-order dynamics of a Typhoid epidemic model

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BioPhysics-Lab, University of Yaoundé 1, Cameroon[a], University of Ngaoundéré, Cameroun[b], LASE-Lab, University of Ngaoundéré, Cameroun[c], University of Yaoundé 1, Cameroun[d]

This work deals with the mathematical modelling of Typhoid fever disease dynamics using Caputo type fractional derivative. After the formulation of the model, we compute the basic reproduction number R_0 and prove the local and global stability of the Typhoid-free equilibrium whenever $R_0 < 1$. For $R_0 > 1$, we prove that there exists only one endemic equilibrium which is globally asymptotically stable. Then, we prove existence and uniqueness of solution as well as its global stability using the Ulam-Hyers criterion. We finally perform numerical simulation to validate our theoretical results.

8AM Control, Optimization and Stochastic Methods
(Room 04, Chair person : Pr . . . .)

Multi-Aggregation Strategies in Ensemble-Based Machine Learning and Deep Learning Models for Cough-Based COVID-19 Detection

Takieddine Lombarkia[a], Farid Marir[a], Naila Marir[b]

SISCOM Laboratory, Constantine 1 - Frères Mentouri University, Algeria[a], LIRE Laboratory, University Abdelhamid Mehri, Constantine 2, Algeria[b]

Respiratory diseases have become a major area of research, especially during the fight against the Coronavirus Disease (COVID-19) pandemic. While various measures have been taken to prevent and control the spread of the virus, the existing diagnostic methods can be time-consuming and invasive. This paper describes a novel framework utilizing Multi-Aggregation Strategies in Ensemble-Based Machine Learning and Deep Learning (MASE-MDL) to detect COVID-19 through cough analysis. Our method employs a comprehensive feature extraction process from cough audio signals. Initially, raw cough audio data undergo preprocessing steps, including noise reduction and signal normalization, to enhance signal quality and consistency. Subsequently, relevant features are extracted from the preprocessed audio signals. These features encompass a range of acoustic characteristics including, but not limited to, frequency spectrum, temporal patterns, and spectral entropy while capturing diverse aspects of cough sounds indicative of respiratory conditions. Moreover, to leverage the collective intelligence of multiple predictive models, such as machine learning algorithms and recurrent neural networks like GRU and LSTM, we employ a multi-aggregation strategy. This approach combines predictions from diverse models, each trained on distinct feature subsets or utilizing different learning algorithms. Tests on the CoughVid dataset have shown high accuracy, sensitivity, and specificity, indicating its potential as a reliable screening tool for healthcare professionals. Furthermore, this approach helps develop new diagnostic techniques that do not require laboratory tests or CT scans. Ultimately, this could lead to better health outcomes for patients and improved respiratory disease management in hospitals.

A note on Additive Model Building for Spatial Functional Regression

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Laboratoire de Probabilité, Statistique et Informatique, Unité de Recherche en Mathématiques et Informatique, Université des Sciences et Techniques de Masuku, Franceville, Gabon[a]

We consider the problem on additive model building for spatial functional regression, where a scalar response is related to the components of a square-integrable spatial functional process. We propose a methodology that leads to the minimisation of a spatially weighted ℓ_2-error norm with a group LASSO type penalty, which constitutes our selection criterion. The originality of this proposed method is that we consider spatially dependent functional data as covariates. A simulation study highlights the importance of the choice of the spatial weight matrix as well as the appreciable asymptotic behaviour of the estimators. Precisely, our method selects better in the case of strong spatial dependency than in the independent data case and increasing the sample size clearly improves the number of selected variables using the proposed criterion for this study with probability converging to 1.

Quadratic Programming Problems with Preprocessing and a Diagonally Dominant M-matrix

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Research Unit LaMOS, University of Bejaia, Algeria[a]

In this study, we propose an new approach for solving a quadratic programming problem with diagonally dominant M-matrix and box constraints. This approach is based on the preprocessing technique, as well as an algorithm inspired by a method of Voglis and Lagaris. The principle of this approach is to apply a preprocessing technique initially to reduce the size of the original problem. The preprocessing step allows to identify certain active and inactive indices at the optimum, in order to fix in advance the corresponding values of certain variables, and put the others in the support set J_S. In order to solve the resulting reduced problem, we then developed an approach inspired on the method of Voglis and Lagaris which falls into the category of exterior point and active set techniques (Kunish and Rendl). Using the notion of support for an objective function developed by Gabasov et al., our approach leads to a more general condition which allows to have an initial pseudo-solution, related to a coordinator support and close to the optimal solution.

Cap Carbon (Phare)
(Caverne de Raymond Lulle)

Les Aiguades
(Plage de galets et Source d'eau)

Zawiyya – Institut Sidi Touati
(Amiral Piri Reis)

Place 1er novembre
(Place De Gueydon)
Manuel Texeira Gomès

Hôtel de ville
(Cippe romain de
l'ingénieur Nonius Datus)

Brise de Mer
(Promenade Fibonacci)

Casbah de Béjaïa
(Mosquée Ibn Khaldun)

Maison d'hôte de la Wilaya
(Le géomètre – ingénieur
Albert Ribaucour)

Départ Port de Béjaïa

Bab el Bahr
(Porte Sarazine)

1	Ibn Hammad
2	Léonardo Fibonacci
3	François Arago
4	Raymond Lulle
5	Amiral Piri Reis
6	Ibn Khaldoun
7	Albert Ribaucour
8	Nonius Datus
9	Texeira Gomès

Circuit culturel et touristique du 17e
Colloque Africain d'Informatique et de
Mathématiques Appliquées CARI'2024
(Orienté vers les mathématiques)
Béjaïa, 25 Novembre 2024 à 15h30mn

Wilaya
de Béjaïa

INVITED TALK

Houari Sahraoui

Professeur, Dép. d'informatique et de RO

Professor, Dep. of Computer Science and OR

Vice-doyen à la planification, aux infrastructures et à l'ÉDI

Vice-dean, planning, infrastructure, and EDI

Faculté des arts et des sciences

Université de Montréal

From Form to Content: How Generative AI Transforms Software Development

Houari Sahraoui

Artificial Intelligence has long been a catalyst for assisting and automating tasks in software engineering. Since the 1980s, AI techniques have been leveraged to streamline software development and maintenance, utilizing rule-based systems, probabilistic reasoning, heuristic search methods, and later, learning algorithms. However, the remarkable advancements in deep learning and large language models (LLMs) in recent years have propelled software automation into a new era.

In this keynote, we will explore how the evolution of code language models has paralleled advancements in natural language models. We will delve into how LLMs and generative AI can revolutionize various stages of software development. From generating content that supports design to aligning models across different dimensions to enhance code generation, and employing complex architectures for automating successive tasks, this presentation will illuminate the transformative potential of generative AI in the world of software engineering.

Natural gas consumption forecasting based on weighted ensemble learning

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Laboratoire LITAN, École supérieure en Sciences et Technologies de l'Informatique et du Numérique, Algeria[a], LIMED Laboratory, University of Bejaia, Algeria [b], University of Bejaia, Algeria [c], Data Science and Big Data Lab, Pablo de Olavide University, Spain[d]

Algeria is a country renowned for its gas exports, but there are concerns that the increasing local demand may jeopardize its position as an exporter. In the face of these challenges, it is crucial to improve methods for predicting natural gas consumption. This article presents an innovative approach that combines long Short-Term memory (LSTM) and Seasonal AutoRegressive Integrated Moving Average (SARIMA) methods for predicting natural gas consumption. An accurate predictive model was developed using this approach, utilizing a dataset provided by SONELGAZ CD Bejaia, which includes natural gas consumption data for high-pressure clients from 2015 to 2022.The results demonstrated a prediction error rate of 4.85% for individual client consumption and 4.76% for the entire client set. These findings showcase the effectiveness of the approach in accurately predicting future natural gas consumption. By combining LSTM and SARIMA, the approach offers a significant improvement over individual methods. By anticipating demand fluctuations, this approach contributes to effectively managing this valuable resource, enabling optimal utilization of natural gas in Bejaia.

Machine learning trust prediction using localized nodes characteristics

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Predicting and recommending trust and distrust is undoubtedly crucial in social media. While these concepts may seem intuitive in real life, they are complex in online social networks. Hence the importance of understanding and predicting both trust and distrust in online social networks. However, while social studies have concluded that distrust is as important as trust, it is unfortunately ignored by the traditional approaches which consider it as the absence of trust. In this paper, we have enriched four real-world signed datasets with features such as reciprocity, notoriety, reputation, personal appreciation, and sociability. Using these preprocessed datasets, we put forth an implementation and conducted a comparative study of various prevalent supervised learning methods such as Polynomial regression (PR), K-Nearest Neighbors (KNN), Random Forest (RF), Category Boosting (CatBoost) for the prediction of trust and distrust values. Our comparative study shows that features implying a nodeâĂŹs own characteristics, and its direct neighbors, do provide simple, intuitive, and satisfying predictions.

Enhancing the management of enterprise processes using Deep Learning: Case of the pension management process at the National Social Security Fund of Benin

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Univrsité de Parakou, Parakou, Bénin [a]

This paper addresses the imperative need for enhancing the management of pension payments at the National Social Security Fund (NSSF) of Benin, emphasizing the pivotal role of deep learning methodologies in achieving optimization. As a critical institution safeguarding the financial well-being of the population through social security programs, the NSSF in Benin faces unique challenges in managing the substantial volume of pension payments that occur at regular intervals. The study introduces a pioneering deep learning-based approach designed specifically for the intricacies of pension payment management within the context of the NSSF in Benin. Leveraging advanced neural network architectures, our methodology aims to streamline and optimize the processes involved in handling pension disbursements, with a focus on improving accuracy, efficiency, and overall operational effectiveness. Key components of the proposed approach include the analysis of historical pension payment data, demographic trends, and relevant socioeconomic indicators to develop predictive models. These models serve to forecast and adapt to changing patterns, ensuring timely and accurate pension disbursements. Through a detailed case study on the National Social Security Fund of Benin, we showcase the practical application of deep learning in addressing the specific challenges faced by public entities managing pension payments.

A Data-Driven Wildfire Forecasting: Case study of Algeria

Naila Aziza HOUACINE[a], Fethi AZIBI[a], Serine Nada BENDJEBBAR[a]

USTHB-LRIA, Algeria[a]

Wildfires break out worldwide every year. To reduce losses, automatic, efficient, and optimal fire forecasting is necessary. In this work, we first built an extensive dataset considering a maximum number of fire-triggering factors. The proposed dataset integrates five relevant factors to wildfire events: Human factors, Land Cover, Soil Composition, Meteorological factors, and Wildfire history. To meet the need for practical fire prediction solutions, we tested several recent and promising algorithms, including Long and Short-Term Memory (LSTM), Bidirectional-LSTM (Bi-LSTM), Random Forest (RF), Logistic Regression (LR), and Artificial Neural Networks (ANN). We also experimented with different data policies, such as the data balancing policy and the model's data feeding, separating or combining the static and time series features. Our study shows that RF methods combined with the Over-sampling balancing policy applied to the global dataset strategy gave the best results.

4CS IMAGE PROCESSING AND COMPUTER VISION
(Room 02, Chair person : Pr . . . .)

An Advanced Object Detection for the Visually Impaired by using YOLOv5+

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This paper presents an improved version of the YOLOv5 architecture adapted specifically for applications in assisting visually impaired individuals. Leveraging advancements in computer vision and deep learning techniques, our modified YOLOv5 model offers enhanced capabilities in object detection and scene understanding, crucial for aiding visually impaired users in navigating and comprehending their surroundings. The modifications to the YOLOv5 architecture include the incorporation of Cross Stage Partial-Pooling with 3x3 filters (C3) blocks in both the backbone and head sections, along with the integration of a Transformer module (C3TR) at the end of the backbone. These enhancements facilitate more effective feature extraction, enabling the model to capture diverse representations of visual stimuli and address complex visual patterns and dependencies inherent in real-world scenes. Furthermore, the modified architecture maintains consistency in feature processing throughout the network, contributing

to improved robustness and accuracy in object detection tasks. Through rigorous experimentation and evaluation, we demonstrate the efficacy of our proposed modifications, showcasing notable advancements in the model's ability to detect objects accurately and provide comprehensive scene descriptions. The improved YOLOv5 architecture holds significant promise in empowering visually impaired individuals with enhanced perceptual capabilities, thereby fostering greater independence and accessibility in their daily lives.

New approach based on alliances in graphs for image segmentation

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Breast cancer is the type of cancer that develops from breast tissue. It is the most common cancer in women. Early detection of breast tumor is crucial in the treatment process. Magnetic Resonance Imaging (MRI) is a valuable tool for identifying and monitoring cancerous breast tumors and interpreting suspicious regions, because MRIs have excellent soft tissue imaging capability. However, this requires an experienced radiologist to analyze and interpret the data. On the other hand, image segmentation can help radiologists and doctors in the diagnosis of the disease and in the planning of its treatment. In this paper, we propose a new approach based on alliances in graphs for image segmentation, called ŞGA2ISŤ, which we apply to breast MRIs to extract existing tumors. The proposed approach has been tested and evaluated on the private dataset *CMH-LIMED* and has been compared with several concurrent methods in the literature. The obtained results, by considering several comparison metrics, have been in favor of the proposed GA2IS approach.

ShipFPN: New Feature Pyramid Network Architecture for Object Detection in High-Resolution Satellite Images: Application to Ship Detection

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Object detection in high-resolution satellite imagery (HRSI) is critical for various applications, including maritime surveillance, natural disaster management, and environmental mapping. Accurately detecting ships in HRSI images presents challenges due to the variability in ship appearances, changing lighting conditions, and complex backgrounds. In this paper, we introduce ShipFPN, an innovative architecture that integrates meta-learning and data generation techniques to enhance model performance and robustness, particularly for under-represented ship categories. Our approach utilizes spectral convolutions to leverage the rich spectral information in satellite imagery for improved vessel discrimination. Additionally, we incorporate a meta-learning module to efficiently adapt the model to detect poorly represented ship categories and propose a synthetic data generation method to enrich the dataset, enhancing the model's robustness against variations in vessel appearance. We also revise the formula for calculating the levels of the feature pyramid to better manage objects of varying sizes, especially large ships, and adopt an oriented bounding box generation technique to accurately localize vessels in the images. The effectiveness of ShipFPN is demonstrated through extensive evaluations on the ShipRSImageNet dataset, showcasing significant improvements in detection performance over existing FPN models.

Identification of Non-Plant Elements in Herbarium Images Using YOLO

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Herbarium scans are an essential resource for studying plant adaptation to climate change and responses to various environmental factors. Automation of functional trait characterization and measurement from these images is crucial for scaling-up and advancing research in plant taxonomy while improving biodiversity documentation. Traditionally, the extraction of these data is conducted manually, a labor-intensive and error-prone process. Nonetheless, in order to derive meaningful data and knowledge, the automated analysis of these images presents significant challenges due to variations in scale, complex backgrounds, and differences in specimen color, shape, and orientation. Advanced computer vision and text mining techniques offer the potential to unlock extensive potential in the field of biodiversity by facilitating the rapid extraction of text- and trait-based information from digital herbarium images. In this study we developed multiple object detection models utilizing a series of YOLO inspired algorithms and digitized collection images from the major Museums of Natural History in France. These models were trained on 722 manually annotated images and validated on a subset of 80 images, to effectively identify six non-plant component types in the digital specimen images, namely envelope, stamp, barcode, textbox, color palette, and scale bar. These models can be used to identify herbarium specimens that contain any of these components for detailed analysis (such as text boxes) or to recognize specimens that lack these elements, facilitating the enhancement of collections. Additionally, determining the frequency of such non-plant components can promt new studies. The overall performance analysis indicates that the YOLOv7-ag model surpasses other models.

3AM PREDATOR - PREY SYSTEMS 1
(Room 03, Chair person : Pr . . . .)

Modeling and analysis of Covid'19 patients hospitalization dynamic reliability by a semi-Markovian model

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We have data on the follow-up of covid'19 patients in Madagascar's two major hospitals during the first two waves of the epidemic. According to specialists, the daily oxygen saturation and requirement allow us to characterize the form of the patient's case in free different states : mild form, moderate form, severe form. We propose a semi-Markovian model with five states (Mild form, Moderate form, Sever form, Cured and Deceased) to analyze the time scales of recovery and death as well as the probability of recovery and death as a function of patient status. The model was also used to measure the dynamic reliability of care up to hospital discharge, i.e. the probability of not being severely ill as a function of hospitalization time.

The operating diagram of an SIS model in the chemostat

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This paper investigates the dynamics of a chemostat model incorporating two populations of one bacterial species: susceptible and virus-infected. Through the two operating parameters of the model, represented by the input concentration of the nutrient and the dilution rate of the chemostat, we analyze the existence

and stability conditions of all possible equilibria, and then describe the operating diagram of the model, which is the bifurcation diagram giving its behavior with respect to those operating parameters, that visually depicts the various regions of stability of those equilibria. This diagram gives a better understanding of the complex interplay between bacterial populations growth, viral infection and environmental factors, in a controlled environment.

On a competition model of two toxin-producing species in the chemostat

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University of Tunis El Manar, National Engineering School of Tunis, LAMSIN, Tunisia[a], University of Monastir, Higher Institute of Computer Science of Mahdia, Tunisia[b]

Understanding and exploiting the competition and allelopathic effects of toxic substances on marine aquatic ecosystems or biodiversity in the soil or among plants is a major challenge in microbial biology and ecology. In this work, we focus on a model of the chemostat of two toxin-producing microbial species competing for a single nutrient. Each species produces toxin which affects the growth of the other species as well as its growth. Removal rates are distinct and include the specific mortality rate and autotoxicity of each species. Our study provides a complete analysis of the model by analyzing the joined effects of competition, allelopathy, and mortality. Using general monotonic growth rates, the mathematical study establishes the conditions of existence and local stability of all equilibria according to the control parameters. The model can present the multiplicity of the coexistence steady states. Numerical simulations show that the three-dimensional system can exhibit bistability where the asymptotic behavior of the system depends on the initial condition.

4AM PERFORMANCE AND RELIABILITY EVALUATION
(Room 04, Chair person : Pr . . . .)

Beta Prime Kernel Availability Density Estimation of a Repairable Series System

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This work considers the availability probability density function estimation based on beta prime kernel of a repairable series system, in the case of identical components operating independently, in the context of non negative data. We have obtained certain properties of the estimator such as bias, variance, optimal convergence rate for mean squared error (MSE) and integrated mean squared error (MISE). In addition, for the bandwidth selection method, we use cross-validation and rule-of-thumb approaches and compare their performances. Finally, a simulation study, sensitivity analysis and a real data application are presented to illustrate the results.

Imperfect maintenance of series systems

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LaMOS Research Unit, University of Bejaia, Algeria[a]

Among imperfect maintenance models, hybrid ones give interesting results when modeling the effect of replacing one or several components on the behavior of a multi-component systems, whatever their configurations. The herein paper, which concerns series systems, aims at studying the effect of the replacement time and the number of replaced components on the imperfect maintenance hybrid model with three parameters (i.e. geometric and arithmetic adjustment of failure rate parameters and virtual age adjustment parameter). A mathematical model is then fitted for each hybrid model parameter. This will allow a realistic modeling and planning of maintenance tasks of series systems.

Performance Evaluation of a Web services System

Bernine Nassima[a], Nacer Hassina[b], Adel-Aissanou Karima[a], Aissani Djamil[a]

LaMOS Research Unit, University of Bejaia, Algeria[a], MOVEP Laboratory, University of Science and Technology, Algeria[b]

A Web service designates a new type of software component having the capacity to publish its functions on the Internet in the form of services, and to make these services easily invocable and to make them available to clients through standard Internet protocols. However, Web services as they are presented are limited to simple functionalities, so the task of composing existing Web services is essential in order to satisfy a complex request of clients. In this work, we proposed a model for the performance evaluation of a Web services system based on an open tandem queue network, with three stations, taking into account client requests. An analysis and modeling of this system with a Jackson network is reported. We calculated the average response time in the system, the average number of clients in the system, the average number of clients waiting in the system, and the average waiting time as a function of λ.

The fair OFDMA-FD MAC for 802.11be and 802.11ax

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LaMOS Research Unit, University of Bejaia, Algeria[a], MOVEP Laboratory, Research Unit LaMOS, Higher School ESTIN, Algeria[b]

The advent of new generations of wireless, such as 802.11ax and 802.11be, marks a major step forward with the integration of SIC (Self Interference Cancellation) antennas. This integration enables full duplex communications, where a Wi-Fi antenna can receive and transmit signals simultaneously, a feature not possible with previous Wi-Fi standards. In this article, we focus on the medium access layer of next-generation wireless networks, highlighting full duplex communications that are primarily based on the OFDMA (Orthogonal Frequency Division Multiple Access) technique. We propose a new technique that combines OFDMA and full duplex mechanisms, which significantly improves performance in terms of throughput and ensures fair access to stations in both uplink and downlink transmissions.

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CARI, the *African Conference on Research in Computer Science and Applied Mathematics,* is the fruit of international cooperation between African, European and international research institutes. Organized every two years since its first edition in Yaoundé in 1992, **CARI** is more than just a scientific meeting, but a dynamic environment for cooperation that brings together researchers and decision-makers in the fields of Computer Science and Applied Mathematics.

Today, the 17th **CARI'2024** Conference is taking place in Bejaia (Algeria). It is organized under the auspices of **ASDS** (*African Society in Digital Sciences*) in partnership with several specialised institutions.

This Abstract Book of around fifty pages brings together the abstracts of the 79 communications selected by the TPC – Technical Programm Committee. The scientific program, which reflects the richness and diversity of research carried out on the African continent in particular, focuses on work likely to contribute to scientific and technological development, environmental awareness and natural resource management.

The 42 communications in Computer sciences were divided into 7 general themes : .« Optimization and Heuristics », « Cluster Analysis, » « Reactive Systems », « Knowledge Discovery, Natural Language and Speech Processing », « Information Security », « Deep and Machine Learning », « Image Processing and Computer Vision » . As for the 37 Applied Mathematics communications, they were divides in 04 axes: « Control, Optimization and Stochastic Methods », « Fractional Dynamics for Epidemic Models », « Predator – Prey Systems », « Partial Differential Equations Modeling » and « Performance and Reliability Evaluation ».

The complete texts will be published by the prestigious publishing house « Springer » : Springer Nature Vol. 643902 for the Mathematics section and Springer CCIS series for the Computer Sciences section.

CARI'2024