NEO

NUMERICAL AND EVOLUTIONARY OPTIMIZATION

11th International Workshop on
Numerical and Evolutionary Optimization
September 03-06
Mexico City, Mexico

CONAHCYT

Cinvestav

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Universidad Veracruzana

aws

Mathematical and Computational Applications

MDPI

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ITT TIJUANA, BAJA CALIFORNIA

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Additional Information

Foreword

Welcome

Welcome to NEO 2024, the 11th International Workshop on Numerical and Evolutionary Optimization. This years' edition is held September 03 - 06, 2024, in the facilities of the Cinvestav, Campus Zacatenco.

The goal of the Numerical and Evolutionary Optimization (NEO) workshop series is to bring together people from these and related fields to discuss, compare and merge their complementary perspectives. NEO encourages the development of fast and reliable hybrid methods, that maximize the strengths and minimize the weaknesses of each underlying paradigm; while also applying to a broader class of problems. Moreover, NEO fosters the understanding and adequate treatment of real-world problems, particularly in emerging fields that affect us all such as healthcare, smart cities, big data, among many others.

When including the Research Experience Day (RED), this years' edition will have a total of 100 presentations from participants coming mainly from all over Mexico. However, thare are also (virtual) particiations from researchers coming from Canada, China, Finland, France, the Netherlands and the Ucraine. It is worth to notice that over the years, the NEO community has grown not only in number but also concerning gender diversity. This year we arrange also, as now it is common since 2018, a special session called Women at NEO (W-NEO) as an effort to make more visible the work in optimization performed by our female pairs. Finally, the NEO X will hold the RED again, where undergraduate students can attend conferences, tutorials, and discussion panels focused on awakening their interest in the wide variety of research career opportunities available to them. We hope you enjoy your participation at the NEO 2024, thank you for your valuable assistance.

Sincerely,
Dr. Oliver Schütze, Cinvestav
NEO 2024 General Chair

Acknowledgments

We want to thank all participants that helped to make the NEO 2024 such a great success.
In particular, we would like to thank our Keynote Speakers:
Kalyanmoy Deb, Michigan State University, USA,
Laura Cruz Reyes, TecNM Madero, Mexico, and
Ting Hu, Queen's University, Canada,

as well as the Speakers and Participants of the Research Experience Day 2024:
Dr. Carlos A. Coello Coello, Cinvestav,
Laura Cruz Reyes, TecNM Madero,
Miriam Pescador Rojas, IPN - ESCOM,
David Laredo, Amazon,
Lourdes Fabiola Uribe Richaud, Anahuac University, and
Xavier Esquivel, Oracle.

Further, we thank the institutions
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Cinvestav,
Universidad Veracruzana,
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our academic colleagues
Daniel E. Hernández Morales, TECNM/IT Tijuana,
Octavio Ramos-Figueroa, UV Xalapa,
Brisbane Ovilla, Cinvestav,
Cuautehmoc Mancilla López, Cinvestav,

and the staff members
Marco Antonio Ortega Flores, IPN,
Katia Ocampo, Cinvestav,
Santiago Dominguez, Cinvestav,
Jose-Luis Flores, Cinvestav,
Adriana Martinez, Kreaprom SA de CV and Impakt 45 SA de CV, and
Everett Zhu, MDPI.

NEO 2024 Organizing Committee

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IMPAKT 45

Schedule

Schedule

Day 1, September 03, 2024 (RED and Tutorials)

"(V)" denotes virtuall participation

08:00 — 09:00	Registration
09:00 — 09:15	Opening
09:15 — 10:00	Bio-inspired Metaheuristics for Optimization: The Last Frontier **Dr. Carlos Coello**
10:00 — 10:20	Coffee break
10:20 — 10:50	Overview of Discrete Optimization **Dr. Laura Cruz**
10:50 — 11:20	Overview of Continuous Optimization **Dr. Miriam Pescador**
11:20 — 12:20	Job Opportunities in Academia and Industry Participants: **Dr. Oliver Cuate (IPN - ESFM), Dr. Laura Cruz (TecNM Madero), Dr. Miriam Pescador (IPN - ESCOM), Dr. Carlos Coello (Cinvestav), David Laredo (Amazon), and Xavier Esquivel (Oracle)**
12:20 — 12:40	Coffee break
12:40 — 13:40	Admission Requirements (IPN, Cinvestav, ITT, UV) Questions and Answers
13:40 — 14:00	Group Photo
14:00 — 15:00	Lunch and Poster Session
15:00 — 18:00	Tutorials (free access for all RED and NEO attendees)

Day 2, September 04, 2024

08:00 — 09:00 Registration

09:00 — 09:30 Opening

09:30 — 10:50 Session I (EMO1, 4 talks, Auditorium Jose Adem) Chair: Efren Mezura-Montes

- Hypervolume Gradient Subspace Approximation
  Ke Shang (V)
- Optimizing Recoverable Robustness of Power Distribution Networks
  Michael Emmerich (V)
- A Novel Framework for Multi-objective Algorithms by Means of Hausdorff Approximations
  Carlos Hernández
- Hypervolume Indicator Gradient and Hessian: Analytical Expressions and Algorithms
  Hao Wang (V)

10:50 — 11:10 Coffee break

11:10 — 12:10 Keynote I, **Kalyanmoy Deb**
Evolutionary Multi-objective Optimization for Practicalities

12:10 — 12:20 Group Photo

12:20 — 13:10 Poster session (see last page for details)

13:10 — 13:40 Lunch break

13:40 — 14:40 Session II (EMO2, 3 talks, Auditorium Jose Adem) and Session III (AML1, 3 talks, Aula A)

Session II Chair: Oliver Schütze

- Finding ε-locally Optimal Solutions for Multi-objective Multimodal Optimization
  Angel E Rodriguez-Fernandez
- Resolving Contrast and Detail Trade-Offs in Image Processing with Multi-Objective Optimization
  Daniel Molina-Pérez
- Multi-Objective Harmony Search Algorithm with Improved Harmony Creation
  Alfredo Peña-Ramos (V)

Session III Chair: Daniel E Hernández

- TaePredict to Forecasting Time Series based on Threshold Accepting Algorithms]
  Juan Frausto Solis (V)
- Classification of Scientific Texts via Support Vector Machines. Case Study Texts on Cybersecurity 2018 to 2023
  Javier Isaac Cázares Vieyra

- Evaluation of Machine Learning Methods for Temperature Prediction in Mexican Regions
  Erika Alarcon-Ruiz (V)

14:50	Transportation to hotel
16:20	Transportation to gala dinner
22:00	Transportation to hotel

Day 3, September 05, 2024

09:00 — 09:30 Registration

09:30 — 10:30 Keynote II, **Laura Cruz Reyes**
Innovating Multiobjective Optimization with Machine Learning

10:30 — 10:50 Coffee break

10:50 — 11:50 Session IV (Opt.Ind.1, 3 talks, Auditorium Jose Adem) and Session V (AML2, 3 talks, Aula A)

Session IV Chair: Oliver Cuate

- Backup Solutions for the Refueling Problem in Foreign Transportation: A Case Study in Mexico
  Rubén Z Belmont
- Parameter Estimation on Kluyveromyces Marxianus Strains through Computational Modelling and Nonlinear Regression
  Emmanuel Rodriguez
- Improving Wind Speed Forecasts in the State of Michoacan through Dynamical Downscaling
  Maritza Bernabe (V)

Session V Chair: Daniel E Hernández

- Cloud Computing to Accelerate Research: Bridging the Gap Between Experiments and Prototypes
  David Laredo Razo
- Validation of Wind Speed Forecasts Developed With the Weather Research and Forecasting model
  Damian Campuzano Milian (V)
- AI-Driven Data Interaction: Pioneering Innovation with Secure, Seamless Enterprise Integration
  Roman Pineda Soto (V)

11:50 — 12:10 Coffee break

12:10 — 13:10 Session VI (AWS, 1 talk, Auditorium Jose Adem) and Session VII (HHO, 3 talks, Aula A)

Session VI Chair: Daniel E Hernández

- Introduction to AWS
  David Laredo

Session VII Chair: Octavio Ramos-Figueroa

- A Hyper-Heuristic Approach for Diversity Control of Grouping Genetic Algorithms
  Octavio Ramos-Figueroa
- New Metaheuristics to Solve the Internet Shopping Optimization Problem with Sensitive Price
  Miguel Garcia (V)
- Exploring the Synergy between M3GP and t-SNE for Enhanced Multiclass Classification
  Luis Muñoz (V)

13:10 — 15:10 Lunch break / Workshop "Generative Artificial Intelligence with AWS" (Auditorium Jose Adem)

15:10 — 16:10 Session VIII (Disc.Opt., 3 talks, Auditorium Jose Adem) and Session IX (GP-EML, 3 talks, Aula A)

Session VIII Chair: Marcela Quiroz

- A Mixed Integer Programming Approach for the Unequal Area Facility Layout Problem
  Saúl Domínguez Casasola (V)
- Optimization of Generalized Assignment Problem for a Machinery-Aided Composting Process
  Lourdes Uribe
- Online Selection of Mutation Operators for the Grouping Genetic Algorithm with Controlled Gene Transmission for the Bin Packing Problem
  Stephanie Amador Larrea

Session IX Chair: Leonardo Trujillo

- M5GP: Parallel Multidimensional Transformation for Symbolic Regression
  Luis A Cardenas Florido
- Understanding the COVID-19 dynamics in Mexico trough mathematical modelling, biostatistics and in silico experimentation
  Paul A Valle
- Fuzzy Grammatical Evolution
  Enrique Naredo (V)

16:10 — 16:30 Coffee break

16:30 — 18:30

- Tutorial: Archiving in Evolutionary Multi-objective Optimization (Jose Adem)
  Oliver Schütze

16:30 — 18:30

- Tutorial: Variation Operators for Grouping Genetic Algorithms (Aula A)
  Marcela Quiroz-Castellanos and Octavio Ramos Figueroa

19:00 — 21:00 Women at NEO

Day 4, September 06, 2024

09:00 — 10:00 Keynote III, **Ting Hu (V)**
Simplicity Bias and Neutrality in Genetic Programming

10:00 — 10:20 Coffee break

10:20 — 11:20 Session X (CV1, 3 talks, Auditorium Jose Adem) and Session XI (AML3, 4 talks, Aula A)

Session X Chair: Luis Gerardo de la Fraga

- Spiking Neurons Performing Image Processing Tasks
  Luis Gerardo de la Fraga
- A Real-world Dataset for Analyzing Cultured Fish Behavior
  Osbaldo Aragón-Banderas
- Multiclass Evaluation of Vision Transformers for Industrial Defect Detection
  Ricardo Rioda Santiago

Session XI Chair: Daniel E Hernández

- Graph-based Representation of a Problem Set Using the Optimal Transport Dataset Distance
  Joel L Nation
- Analysis of GUIs from a Gender Perspective for their Characterization through Pattern Recognition
  Paulo César Portilla-Tirado
- Feature Extraction Toolkit for Multi-channel Signal Classification
  Daniel E Hernandez
- YOLO versions analysis for detection of types and subtypes in images
  Alan González Hernández

11:20 — 11:40 Coffee break

11:40 — 12:40 Session XII (Model, 3 talks, Auditorium Jose Adem) and Session XIII (CV2, 3 talks, Aula A)

Session XII Chair: Leonardo Trujillo

- Thau Observer for Insulin Estimation Considering the Effect of Beta-cells Dynamics for a Diabetes Mellitus Model
  Diana Gamboa
- Evolutionary algorithm and EEG classification for the detection of mental states
  Pierrick Legrand (V)
- Consistent Conjectural Variations Equilibrium for a Human Migration Model
  Daniela Osorio Gonzalez

Session XIII Chair: Lourdes Uribe

- Automatic Detection of Fiducial Markers with Yolo v5 Deep Network
  Luis Gerardo de la Fraga
- Facial emotion recognition by means of convolutional neural networks for estimating ergonomic measures
  Israel Cordova

- An Enhanced Image Segmentation Algorithm Inspired by Mean Shift and Particle Swarm Optimization
  Luis Fernando Hernandez Bravo

12:40 — 13:00 Closing

Poster session, September 04, 2024

- A Newton Method for Hausdorff Approximations of the Pareto Front within Multi-objective Evolutionary Algorithms
  Oliver Schütze
- RSG, a Method for Pareto Front Approximation and Reference Set Generation
  Angel E Rodriguez-Fernandez
- On Objective Reduction of Many-objective Optimization by Means of Performance Indicators
  Fernando Avitúa Varela
- A R2 Based Multi-objective Reinforcement Learning Algorithm
  Sofia Magdalena Borrel Miller
- The Pareto Tracer for the Treatment of Degenerated Multi-objective Optimization Problems
  Oliver Cuate
- Multiobjective Reinforcement Learning for Water Distribution Network Control
  José A Alonso
- Characterization and Classification of Mexican Woods by Local Texture Analysis Using Deep Learning Techniques
  Juan Pablo Garduza Ventura
- Analysis and Characterization of Digital Images of Land Surface in the Middle Zone of the Mexican State of San Luis Potosi, by Means of CBIR Technique and Evolutionary Computation for Fire Risk Assessment
  José Rodrigo Torres Licona
- Comparison of Multi-objective Evolutionary Algorithms for Fine-tuning a Quantile Forecasting Deep Neural Network
  Daniel Linares Gil
- Lightly Robust Solutions for MOGenConVRP under Uncertainty
  Rodrigo Fernando Velázquez Cruz
- Expected Hypervolume Improvement for Multi-Objective Reinforcement Learning
  Alberto M Millán
- When does Weighted Sum Perform Well on Multi-task Learning?
  María Carmen Aguirre Delgado
- On the Effect of Temporal Heterogeneity on Selection Pressure of Evolutionary Algorithms
  Victor Manuel Sanchez Sanchez
- A Preliminary Study of Collaborative Multi-objective Multi-agent Systems by Means of SAC and PPO

II Invited Speakers

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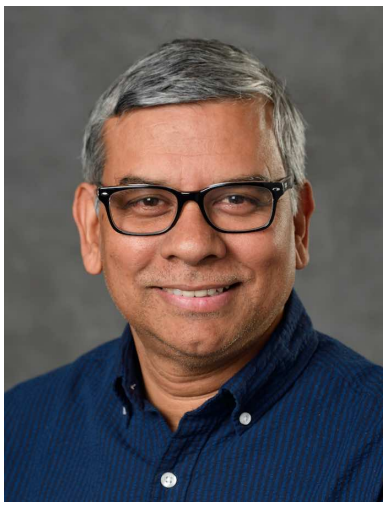
Kalyanmoy Deb

Evolutionary Multi-objective Optimization for Practicalities

Michigan State University, USA

Talk Abstract

Evolutionary multi-objective optimization (EMO) algorithms are capable of finding multiple trade-off optimal solutions in a single application. This aspect alone has made them attractive for handling multiple conflicting objectives for the past three decades. EMO algorithms are adapted for handling various other practicalities, such as robustness, reliability, hierarchy, expensive evaluation functions, etc. In this talk, we discuss two practicalities – finding regularized trade-off solutions with certain common properties and finding intermediate transitional solutions from current to target – proposed recently using updated EMO algorithms. Results will be shown on a number of test and engineering problems.



Short Biography

Kalyanmoy Deb is University Distinguished Professor and Koenig Endowed Chair Professor at Department of Electrical and Computer Engineering in Michigan State University, USA. His research interests are in evolutionary optimization and their application in multi-criterion optimization, modeling, and machine learning. He was awarded IEEE Evolutionary Computation Pioneer Award for his sustained work in EMO, Infosys Prize, TWAS Prize in Engineering Sciences, CajAstur Mamdani Prize, Distinguished Alumni Award from IIT Kharagpur, Edgeworth-Pareto award, Bhatnagar Prize in Engineering Sciences, and Bessel Research award from Germany. He is fellow of ACM, IEEE, and ASME. He has published over 620 research papers with Google Scholar citation of over 206,000 with h-index 141. More information about his research contribution can be found from https://www.coin-lab.org.

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Laura Cruz Reyes

Innovating Multiobjective Optimization with Machine Learning

ITCM of TecNM, Mexico

Talk Abstract

Machine learning, a branch of artificial intelligence, utilizes data to identify patterns and create predictive models. Today, machine learning is redefining the approach to process optimization, unlocking new possibilities for improvement. Traditionally, optimization relied on mathematical models and specific algorithms such as heuristics and metaheuristics to solve problems efficiently. However, the integration of machine learning has brought about a significant shift in this perspective. This talk will explore how machine learning has transformed optimization esearch and is continuously doing so by offering a more flexible approach to adapt to problem changes. This innovation has enabled the dynamic, real-time optimization of problems at previously unattainable scales and complexities. Specifically, some research strategies that have been proposed, as well as future possibilities and examples of real-world applications, will be presented. The challenges of this intelligent optimization approach will be discussed, which seeks to significantly integrate machine learning into process optimization to enhance system efficiency and performance.

Short Biography

Laura Cruz-Reyes holds a Ph.D. in Computer Science, two master's degrees in Computer Science and Information Systems, and a bachelor's egree in Chemical Engineering in Production. She is a level III National System of Researchers (SNI) member under CONAHCYT and a full-time Computer Science professor at the Instituto Tecnológico de Ciudad Madero. She leads the Intelligent Optimization research group and three research networks and has established postgraduate programs and the National Laboratory of Information Technologies. Internationally, she collaborates with the University of Cádiz and is Vice President of the Eurekas Community. Her research focuses on solving complex optimization problems using AI and operations research, with interests in metaheuristics, machine learning, fuzzy logic, multi-criteria decision-making, and logistics. She is active in science dissemination, having served as a guest editor and reviewer for journals. She was editor-in-chief of the Komputer Sapiens journal, achieving its inclusion in the CONAHCYT index.

Ting Hu

Simplicity Bias and Neutrality in Genetic Programming

Pontificia Universidad Javeriana, Colombia

Talk Abstract

Nature often favors simple solutions, as evidenced by the prevalence of symmetrical and simple structures in the natural world. But can we quantify this observation? If so, to what extent? What evolutionary explanations might account for this phenomenon? In this talk, we explore these questions within the context of genetic programming. We propose an explanation for the simplicity bias observed in genetic programming, using the concepts of redundancy and neutrality in the genotype-to-phenotype mapping.

Short Biography

Dr. Ting Hu is an Associate Professor at the School of Computing, Queen's University in Kingston, Canada. Her research focuses on explainable AI, evolutionary computing, and machine learning applications in biomedicine. Ting serves as an Area Editor of the journal Genetic Programming and Evolvable Machines, as well as an Associate Editor of the journal Neurocomputing. She has served on multiple occasions as the program co-chair for prominent evolutionary computing conferences such as the ACM Genetic and Evolutionary Computation Conference (GECCO) and the European Conference on Genetic Programming (EuroGP).

III

Special Sessions

Women at NEO

Chair: Marcela Quiroz

The Women at NEO (W-NEO) is a platform to encourage the presence of women in Science, in particular, in Numerical Optimization and Computing. The goal is to gather young and consolidated female researchers and practitioners to share experiences and paths for possible joint work. W-NEO 2024 will be held as a social event in the evening of September 05 in the restaurant "La Parrilla De Tio Closs".

Set Oriented Numerics

Chair: Dr. Oliver Schütze

Set oriented methods have proven to be very efficient in the numerical treatment of various classes of global optimization problems in academy and industry and are widely used in many fields, such as Engineering and Finance. This special session serves as a platform for researchers from all over the world to present and discuss recent advances in set oriented numerical methods in particular in the context of optimization. Methods of this kind iterate (or evolve) entire sets instead of considering point-wise iterative methods and are thus in particular advantageous if a thorough investigation of the entire domain is required and/or the solution set is not given by a singleton.

Topics

- Cell mapping techniques.
- Subdivision techniques.
- Continuation methods.
- Swarm-like strategies.
- Methods for all kinds of optimization problems, including: scalar, multi-objective, bi-level, and dynamic optimization problems, applications to real-world problems.

Optimization in Industry

Chair: Dr. Oliver Cuate

Optimization is present in everyday life, not only in our daily problems but also in the most relevant aspects of the industry. Such applications are increasingly demanding, which has led to the emergence of complex optimization problems that, as a consequence, require more sophisticated solution processes. Currently, it is common to be faced with large-scale optimization problems (i.e., where the number of variables is high), many objective optimization problems (i.e., problems where more than four goals have to be optimized concurrently) and instances with complex constraints (such as equality constraints). Besides, the decision-making process is also an important aspect that must be taken into account in real-world problems.This special session serves as a platform for researchers from all over the world to present and discuss recent advances in optimization applied to complex problems, which are still a challenge for both academia and industry. The aim is the presentation of new challenges by the industry and the proposal of new solution methods by the researchers.

Topics

- Single and multi-objective optimization.
- Many objective optimization.
- Large scale optimization.
- Multi-level optimization.
- Decision-making process.
- Meta-heuristics.
- Constraint handling.
- Modeling and simulation.
- Real-world applications.

Discrete Optimization

Chair: Dr. Marcela Quiroz Castellanos

Applications of discrete optimization problems arise in engineering, science, economics, and everyday life. It is common to find in many real-world linear, as well as nonlinear programming, that all, or a fraction of variables are restricted to be integer, yielding integer or mixed integer-discrete-continuous problems. Many of these problems are computationally intractable. The approaches that are addressing these problems include: traditional optimization techniques, efficient preprocessing schemes, decomposition techniques, fast heuristics, metaheuristics and hybrid methods. This special session serves as a platform for researchers from all over the world to present and discuss recent advances and perspectives in the mathematical, computational and applied aspects of all areas of integer programming, combinatorial optimization and mixed integer-discrete-continuous optimization.

Topics

- Event detection in time series.
- Object recognition.
- Combinatorial approaches.
- Probabilisitic approaches.
- Soft computing approaches.
- Multi-objective optimization in signal processing.
- Complexity analysis of algorithms.
- Image segmentation.
- Applications.

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Hyper Heuristics for Optimization

Chair: Dr. Octavio Ramos-Figueroa

Hyper-heuristic algorithms arise as a proposal to automate the design of optimization algorithms. The methods designed under this approach have a more general vision, i.e., they use search heuristic strategies that can be effective in different problems that share certain characteristics and properties to seek a certain degree of generality. A hyper-heuristic operates with a high-level (meta-)heuristic in charge of determining the best way to select, combine, or adapt different low-level (meta-)heuristics to solve a family of problems. This special session serves as a platform for researchers from all over the world to present and discuss recent advances and perspectives in hyper-heuristic algorithms for optimization.

Topics

- Continuous and combinatorial optimization.
- Single-objective and multi-objective problems.
- Bi-level optimization.
- Hyperheuristics without learning.
- Hyper heuristics with online and offline learning.
- Hyper heuristics based on selection, generation, sequencing, and machine learning.
- Hyper hueristics with low-level heurísticas, metahueristics, and memetic algorithms.
- Hyper heuristics with construction and perturbation heuristics.
- Hyper heuristics for single or multiple benchmarks for a single problem.
- Hyper heuristics for several problems of single or multiple domains.

Applications of Machine Learning

Chair: Dr. Daniel Eduardo Hernández Morales

Machine Learning has become an extremely popular approach for solving complex problems in different domains. The ability to process large amounts of data and extract meaningful insight to create predictive models, in order to enhance decision-making and optimize processes, has revolutionized industries such as healthcare, finance, retail, manufacturing, transportation, and more. This session aims to bring together researchers, practitioners, and industry experts to discuss and showcase the latest advancements in the development of new algorithms or improvements over existing ones, and innovative applications of Machine Learning in various fields.

IV

Contributed Talks

Spiking Neurons Performing Image Processing Tasks

Andres Cureño Ramírez and Luis Gerardo de la Fraga

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In [1] authors use the neuron's model Hindmarsh–Rose (HR), which is a continuous model of a neuron represented with a system of three differential equations, to implement image processing tasks. In this work we reproduce the results obtained in [1]. These neurons are called the third generation of neuron because they behavior is more likely as the biological neuron. Our goal is to understand this kind of neurons that use spikes to represent signals instead of 0's and 1's.

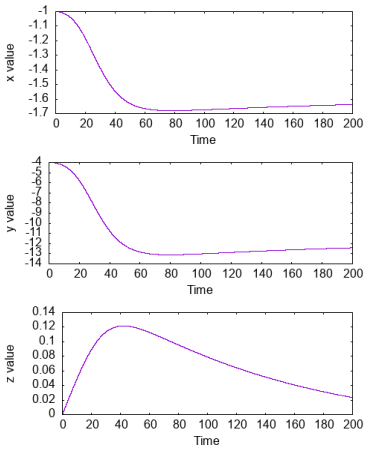


Fig 1(a)

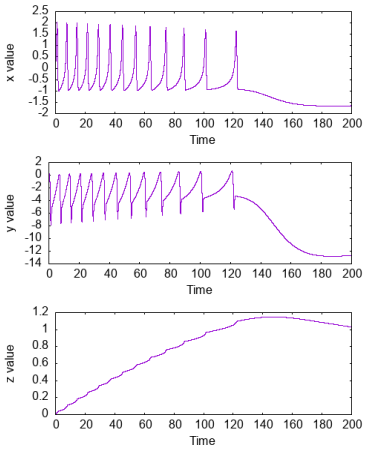


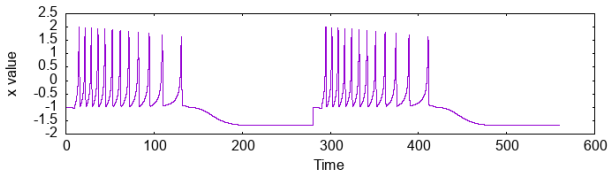
Fig 1(b)

The HR model is defined as

$$\dot{x} = y + 3x^2 - x^3 - z + I$$
$$\dot{y} = 1 - 5x^2 - y$$
$$\dot{z} = 4rx + 6.4r - rz$$

Using the Euler method to integrate the HR model with $r = 0.0021$, $\Delta t = 1/256$, $I = 0$, and initial conditions $[x_0, y_0, z_0] = [-1.0, -4.0, 0.0]$ the behavior is shown in Fig. 1(a), with $I = 1$ and $[x_0, y_0, z_0] = [0, 0, 0]$ the behavior is shown in Fig. 1(b).

A zero can be coded as set $I = 0$ during 10 sec with initial conditions $[-1.0, -4.0, 0.0]$ and then set $I = 0$ during 130 sec. The one can be coded as set $I = 0$ by 10 sec with the same initial conditions and then set $I = 1$ by 130 sec. The signal in x coding '1010' is shown below



It is necessary to design AND, OR, and NOT neurons and with these basic designs is possible to implement more complicated operations [2, 1]. We will also show some comparison results with other neuron model as the one used in [2].

References

[1] S. Nazari, S. Jamshidi, Efficient digital design of the nonlinear behavior of Hindmarsh–Rose neuron model in large-scale neural population. Scientific Reports, 2024, vol. 14, pp. 3833, DOI: 10.1038/s41598-024-54525-8.

[2] S. Nazari, A. Keyanfar, M.M. Van Hulle, Spiking image processing unit based on neural analog of Boolean logic operations. Cognitive Neurodynamics, 2023, vol. 17, no 6, p. 1649-1660. DOI: 10.1007/s11571-022-09917-9.

Automatic Detection of Fiducial Markers with Yolo v5 Deep Network

Christian Ruiz Hernández and Luis Gerardo de la Fraga

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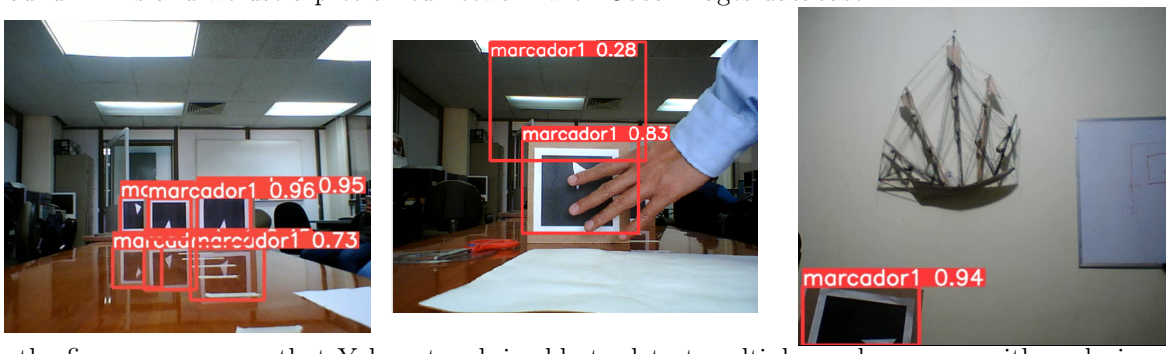
A fiducial marker is a designed planer object that is very easy to be detected with a camera and software. We use markers composed by a black square with a white border, this makes a great contrast; inside the black square can be white triangles or any other figure. With these markers is possible to design virtual augmented scenarios, with one virtual world living inside the reference coordinates of one marker.
Detecting a marker with occlusions, with partial view on an image, or with several of them in an image at the same time are challenging tasks with traditional image processing software, because of these challenges we decide to use the Yolo v5 deep neural network [1, 2] to detect markers.
We use the pinhole camera model and the noise Perlin [3] to generate 2,200 images, 2000 for training and 200 for testing. As a background we use Pelkin noise. The Perlin noise is generated with the general idea that real images have not zones that change abruptly their intensity from 0 to 255, the intensity changes are smooth, thus the marker will be the object with great intensity changes, this helps to extract the marker's characteristics during the training phase. During 300 epochs was tranined the network, this took around 11 hrs and we use a pretrained network with Coco images database.



In the figure we can see that Yolo network is able to detect multiple markers, even with occlusions and partial view in the image border.

References

[1] J. Terven, D.M. Córdova-Esparza, J.A. Romero-González, A Comprehensive Review of YOLO Architectures in Computer Vision: From YOLOv1 to YOLOv8 and YOLO-NAS. Mach. Learn. Knowl. Extr. 2023, 5, 1680-1716. DOI: 10.3390/make5040083.

[2] Pytorch model of Yolo v5 neural nerwork, https://pytorch.org/hub/ultralytics_yolov5/

[3] Perlin-noise 1.12, a python library, https://pypi.org/project/perlin-noise/

A Newton Method for Hausdorff Approximations of the Pareto Front within Multi-objective Evolutionary Algorithms

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A common goal in evolutionary multi-objective optimization is to find suitable finite-size approximations of the Pareto front of a given multi-objective optimization problem. While many multi-objective evolutionary algorithms have proven to be very efficient in finding good Pareto front approximations, they may need quite a few resources or may even fail to obtain optimal or nearly approximations. Hereby, optimality is implicitly defined by the chosen performance indicator.
In this work, we propose a set-based Newton method for Hausdorff approximations of the Pareto front to be used within multi-objective evolutionary algorithms. To this end, we first generalize the previously proposed Newton step for the performance indicator for the treatment of constrained problems for general reference sets. To approximate the target Pareto front, we propose a particular strategy for generating the reference set that utilizes the data gathered by the evolutionary algorithm during its run. Finally, we show the benefit of the Newton method as a post-processing step on several benchmark test functions and different base evolutionary algorithms.

M5GP: Parallel Multidimensional Transformation for Symbolic Regression

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Machine learning (ML) and artificial intelligence (AI) have made significant advances, driven by improvements in processing power, the availability of large amounts of data, and the development of more sophisticated algorithms [1]. They have gained popularity due to their ability to produce models that achieve unprecedented performance in various domains such as computer vision, natural language processing, and code generation. However, we can observe that many of these models can become extremely large and complex, impossible to understand through traditional analysis.

Genetic Programming (GP), since its conceptualization more than 30 years ago [1], was proposed as a general-purpose problem-solving paradigm, applicable to a wide variety of domains, from the synthesis of programs to circuit design [2]. However, the most studied problem in GP has been Symbolic Regression (RS), a type of machine learning problem in which the goal is to predict a real-valued outcome and, at the same time, generate a symbolic model and (potentially) human-readable [1, 3, 4].

Symbolic regression, on the other hand, focuses on generating relatively small and (potentially) human-readable models. In this domain, GP has proven to be a powerful search strategy that achieves performance comparable to the state of the art.

This work describes the development and implementation process of a new GP system that uses parallel processing in Graphics Processing Units (GPU) based on previous models such as Geometric Semantic Genetic Programming (GSGP) and a basic GP algorithm.

The new modeling system is called Parallel Multidimensional Genetic Programming with Multidimensional Populations for Symbolic Regression, and We call it M5GP. This new method is the most recent variant of a family of algorithms that have proven to be powerful tools for classification and regression tasks using tabular data, based on its predecessors M2GP [7], M3GP [6, 8] and M4GP [9]. M5GP [15] produces linear parameter models and exploits parallel processing on GPU for efficient computation, this new method belongs to the class of Constructive Feature Induction (CI) methods. CI consists of rewriting the original representation of the feature space of a problem in a new form, so that the resulting features are logically equivalent to the original ones and improve the accuracy of the representation. In this work We use an approach called “Wrappers”, under which we can apply CI with GP.

The proposed method was evaluated on SRBench V2.0, the current standard benchmark suite for symbolic regression. The results show that M5GP achieves performance that is competitive with the state of the art, particularly on the most difficult subset of black-box problems, in a fraction of the processing time of other methods thanks to its parallel implementation.

An easy-to-use open-source implementation is provided and comparisons with state-of-the-art Symbolic Regression (SR) methods are provided, considering both GP-based and non-GP-based methods (https://github.com/armandocardenasf /m5gp).

The results are published in the following paper: https://www.mdpi.com/2718498 and the source code can be downloaded at: https://github.com/armandocardenasf/m5gp .

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RSG, a Reference Set Generator for Pareto Fronts

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A common issue in evolutionary multi-objective optimization is to find suitable finite-size approximations of the Pareto front (PF) of a given multi-objective optimization problem. This is necessary for obtaining search directions of a multi-objective evolutionary algorithm (MOEA), starting sets for Newton-like methods [**?**] or having a reference set for indicators such as IGD and Δ_p. In this work, we propose a reference set generator (RSG), a method that uses an initial approximation (P_y) of the PF to obtain an evenly spread reference set (Z) of size N. To this end, we first detect the components of P_y, fill each detected component in order to fix small irregularities and finally reduce the set to the desired size N. The particular filling strategy differs between problems with two objectives and problems with three or more objectives. Finally we present some results of the RSG method.

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Finding ϵ-locally Optimal Solutions for Multi-objective Multimodal Optimization

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In this work, we address the problem to compute all locally optimal solutions of a given multi-objective problem whose images are sufficiently close to the Pareto front. Such *ϵ-locally optimal solutions* are in particularly interesting in the context of multi-objective multimodal optimization (MMO). To accomplish this task, we first define a new set of interest, $L_{Q,\epsilon}$, that is strongly related to the recently proposed set of ϵ-acceptable solutions. Next, we propose a new unbounded archiver, $ArchiveUpdateL_{Q,\epsilon}$, aiming to capture $L_{Q,\epsilon}$ in the limit. This archiver can in principle be used in combination with any multi-objective evolutionary algorithm (MOEA). Further, we equip numerous MOEAs with $ArchiveUpdateL_{Q,\epsilon}$, investigate their performances across several benchmark functions, and compare the enhanced MOEAs with their archive-free counterparts. For our experiments, we utilize the well-established metrics HV, IGDX, and Δ_p. Additionally, we propose and use a new performance indicator, I_{EDR}, which results in comparable performances but which is applicable to problems defined in higher dimensions (in particular in decision variable space).

Graph-based representation of a problem set using the optimal transport dataset distance

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Understanding machine learning (ML) tasks is a complex endeavor. Therefore, methods have been proposed to visualize and organize datasets, the learning process itself, and the resulting models. With the rise of ML, the reuse and specialization of models becomes more common, and understanding problem sets is crucial. This work proposes a graph-based representation of ML problem sets. It is based on the Optimal Transport Dataset Distance (OTDD), a new metric for calculating the formal distance between problem sets. This representation allows for the identification of relationships and structures in problem sets, revealing structural properties related to problem difficulty. In comparison to previous feature-based approaches, the OTDD-based graph representation offers a better understanding of the complexity of ML problems that facilitates their analysis and understanding. Results show that applying graph-based analysis to detect communities of problems, for instance, generates groups that are related to common indicators of problem difficulty.

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Analysis of GUIs from a gender perspective for their characterization through pattern recognition

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This research aims to identify how Graphical User Interfaces can be evaluated and understood through the lens of gender, using pattern recognition tools to identify specific characteristics related to this approach. The study is based on intersectional studies and queer theory with the purpose of establishing a theoretical framework in the technological context. The design of a pattern of self-image characteristics is proposed, but also adding a weighting of emotions perceived by a statistical sample of user responses. This is a first work in progress and we have a first result of the analysis of the gender perspective that we propose a discretization for its possible classification from the pattern recognition.

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On Objective Reduction of Many-objective Optimization by Means of Performance Indicators

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In the realm of Multiobjective Optimization Problems (MOPs), several Evolutionary Algorithms have demonstrated effectiveness [1]. However, their efficiency diminishes when dealing with more than four objectives [2]. This decline is partly because the non-dominated region expands significantly, reducing the space for solutions that improve upon previous ones. Additionally, simple transformations of some Pareto fronts can significantly alter the performance of Multiobjective Optimization Evolutionary Algorithms (MOEAs). One strategy to address this issue involves employing Indicator-Based MOEAs.
These algorithms use Quality Indicators (QIs), assessments of Pareto Front approximations focusing on aspects like convergence or diversity of the set [3]. Consequently, this approach effectively simplifies the number of objectives. Specifically, the PFI-EMOA [6] algorithm employs a scalarization of convergence and diversity QIs to guide its search process. Each generation aims to promote a solution that either enhances diversity or approximates closer to the Pareto front.
In this work, we study different scalarizations of convergence and diversity indicators within PFI-EMOA to determine if certain problems exhibit a preference for one over the other, as assessed by other quality indicators. In particular, we used IGD+ [4] and R2 [5] for convergence and Riesz s-energy [7] for diversity. Further, we performed a series of experiments and investigated for statistical significance. We discovered that the selection of quality indicators significantly influences decision-making in algorithm choice for optimizing specific aspects of MOPs. Finally, the findings suggest that certain scalarizations, which prioritize either convergence or diversity, are preferred by specific solutions. For example, when optimizing for convergence indicators such as HV the preferred scalarization is giving more weight to the convergence indicator of the density estimation. However, when optimizing for R2 the behaviour is not monotonic. That is, there are density estimations which give more weight to the diversity indicator and still have a greater R2 after the algorithm is run. In other words, it isn't obvious that preferring a convergence indicator when searching will lead to the best final approximation set in that category.
It is left as future work to determine in which cases the problems favor one solution or the other. This can be done using techniques like Exploratory Landscape Analysis which would take into account the characteristics of both the solution itself and the properties of the Pareto Front we are trying to approximate. Additionally, an interesting avenue would be to explore how to optimize the decision of which indicator to favor step by step rather than keeping it fixed for the whole execution of the algorithm.

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A Review of Machine Learning Applications in Task Scheduling for Cloud Computing

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Abstract The rapid advancement of cloud computing has necessitated the development of efficient task scheduling algorithms to optimize resource utilization and minimize execution time. Recently, machine learning (ML) has emerged as a powerful tool to address these challenges by providing intelligent and adaptive scheduling solutions. This paper presents a comprehensive review of the latest literature on ML applications in task scheduling for cloud computing environments. We examine a variety of ML techniques, including supervised learning, unsupervised learning, reinforcement learning, and hybrid approaches, highlighting their strengths and limitations. Our analysis covers diverse aspects such as prediction accuracy, scalability, adaptability to dynamic cloud environments, and overall impact on system performance. Additionally, we identify key trends and emerging directions in this research domain, offering insights into future developments and potential areas for further exploration. By synthesizing recent advances, this review aims to provide a valuable resource for researchers and practitioners seeking to enhance task scheduling efficiency in cloud computing through ML-driven solutions.

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A hyper-heuristic approach for diversity control of grouping genetic algorithms

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Combinatorial optimization is a branch of mathematics and computer science that focuses on finding high-quality solutions, in terms of some specific criterion, within a space of discrete solutions. Combinatorial problems arise in many daily life situations, e.g., finding the shortest route to visit a set of cities; efficiently distributing resources, such as workers to specific tasks, flights to airplanes, or projects to equipment; designing communication and transportation networks; and creating optimal schedules for schools, universities, hospitals, or industrial production lines. This work focuses on a specific class of combinatorial problems, known as grouping problems, where an efficient distribution of a set V with n elements among a collection of D mutually disjoint subsets (groups) is sought, placing every item into a single group, without allow unassigned items, as well as other constraints of the problem to solve [1]. It is well-known that although these optimization problems are easy to understand, many are inherently complex and fall into the NP-hard class, i.e., no algorithm can solve all possible cases efficiently in a reasonable time [2]. This computational complexity has motivated the scientific community to dedicate considerable efforts to understanding and solving this type of problem in the best possible way. As a result, the specialized literature includes several deterministic, exact, heuristic, metaheuristic, and hyper-heuristic solution methods [1]. One of the most used metaheuristic algorithms to solve grouping problems is the Grouping Genetic Algorithm (GGA), a variant of the traditional Genetic Algorithm (GA) that incorporates an encoding based on groups to represent and manipulate the solutions, as well as variation operators that work at the group-level [3]. Different studies have shown that one of the main challenges when designing effective GAs is identifying the appropriate balance of exploration and exploitation of the search space. One way to reach such a trade-off is by incorporating heuristic strategies to control the diversity of the solutions' population throughout the complete search process [4]. In this work, we leverage the GGA strengths and identify its opportunity areas to produce a more effective solution approach. This improvement proposal includes a scheme to control the diversity of solutions produced by the GGA in each generation through variation operators, changing from one version of the crossover (or mutation) operator to another based on the number of solutions

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that share the same quality. Thus, when the population contains various solutions with the same quality, the GGA uses operators that exhibit behavior to favor exploration. Otherwise, it switches to operators that promote the intensification of the search space. To test this proposal, we used the parallel-machine scheduling problem with unrelated machines and makespan minimization, known as $R||C_{max}$ [5], some state-of-the-art variation operators [3], and the Grouping Genetic Algorithm with Intelligent Heuristic Strategies (GGA-IHS) [5]. As a result of this study, we proposed the Hyper-heuristic Grouping Genetic Algorithm with Intelligent Heuristic Strategies and Online Diversity Control (HGGA-IHS-ODC), which showed promising results concerning the computational time and the quality of the solutions found by solving the $R||C_{max}$ problem.

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A R2 Based Multi-objective Reinforcement Learning Algorithm

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Reinforcement Learning (RL) [1] trains agents to maximize a cumulative reward, typically modeled by a Markov decision process (MDP) with states, actions, transition functions, a discount factor, and reward functions. However, in most real-world problems, decision-makers are interested in multiple rewards, which typically are in conflict. This problem leads to the so-called multi-objective reinforcement learning (MORL) [2]. In this setting, the solution is a set of policies rather than a single one.
Recently, there has been an interest in developing this kind of methods. For instance, the hypervolume indicator was coupled with Q-learning [3] to address this problem. However, hypervolume methods are computationally expensive as the number of objectives increase [4].
Thus, in this work, we propose to adapt Q-learning with the R2 indicator [5] instead of using the hypervolume indicator. The novel algorithm uses an ϵ-greedy policy to select the actions based on their R2 contribution. We performed a comparative study with HB-MORL using the MO Gymnasium framework [6] in Tree Fruits, Resource Gathering, Deep Sea Treasure, Mountain Car, and Four Room environments. These environments range from two to six reward functions. Our results show that the novel algorithm obtains competitive results on the benchmark according to the hypervolume and R2 indicators. The results suggest further exploration of the R2 indicator in RL is promising. Future work will investigate different indicators and algorithms, focusing on adaptability and scalability for real-world applications.

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The Pareto Tracer for the Treatment of Degenerated Multi-objective Optimization Problems

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Multi-objective continuation algorithms are very powerful tools for the numerical treatment of continuous multi-objective optimization problems (MOPs). All of these methods, however, are based on certain regularity assumptions that imply that the solution set of the given MOP form at least locally objects of dimension $k-1$. Hereby, k is the number of objectives considered in the MOP. While this is the case for most problems, there exist examples where the dimension of the Pareto set/front is less than $k-1$, which is called the degenerated case.
In this work, we present and discuss a new predictor step for the use within multi-objective continuation methods that automatically detects (numerical) degeneration, and that can perform movements in "essential" directions. We will further integrate this predictor into the multi-objective continuation method Pareto Tracer. We will finally show on selected benchmark problems that this new continuation method can efficiently handle both degenerated and non-degenerated MOPs.

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Backup solutions for the refueling problem in foreign transportation: a case study in Mexico

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In this work, we addressed an optimization problem in the bus transportation industry from two points of view. Firstly, we used an integer linear optimization model to describe the problem, and we solved it via a mathematical solver and a genetic algorithm.
The problem to be solved is to minimize the recharged fuel cost necessary to complete a trip on a passenger bus from a Mexican company. Among the assumptions of the problem, we have that the bus can only restore fuel at the stops of the trip, the price of gasoline varies at each stop, and the amount of fuel in the tank always has to be greater or equal to a certain reserve amount and less or equal to the tank's total capacity. It is shown that, under certain conditions, the problem always has a solution since we can choose the strategy of recharging in each city until the tank is full, and in this way, we can reach the next city and complete the trip; however, this approach is far from giving an optimal solution.
The integer linear optimization problem arises as a minimization problem with $3n + 1$ constraints, where n represents the number of designated stations that form the trip to be made. In the genetic algorithm approach, the amount of gasoline in the tank was represented as individuals, and suitable mutation and crossover operators were proposed for the problem until a solution yielded good results for the cost function. In the approach with integer linear programming, it was possible to obtain optimal solutions for large instances of the problem in a very short time. Regarding the genetic algorithm, it was possible to get suitable approximations of the optimal points and generate backup solutions for the problem.

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Multiobjective Reinforcement Learning for Water Distribution Network Control

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The present study addresses the problem of designing pumping control strategies in a water distribution network, using an Evolutionary Multi-objective Reinforcement Learning technique. The strength of using a multi-objective criterion is to be able to characterize the objectives of the pressure requirement by sections with prioritization and pumping efficiency, independently. The main challenge in designing the strategies is the management of user demand, which is uncertain, which is why an algorithm with the capacity for reinforcement learning and scaling to complex networks is proposed. In particular, it is proposed to use the Non-dominated Sorting Genetic Algorithm III (NSGA-III) to optimize deep policy neural networks to attack the problem, given that it is a robust algorithm that allows integrating user preferences and has shown its applicability in a wide range of problems. The Anytown water distribution network is used as a case study, which consists of twenty-two nodes, forty-one pipelines, and a pumping station. Subsequently, different demand scenarios are simulated to validate the solutions found, and they were analyzed with respect to the convergence graphs of the hypervolume indicator and pressures in the network. The results show that the generated strategies are competitive for the given problem scenarios. As future work, the application of this methodology to the case of the hydraulic network of a real university campus is planned.

A Mixed Integer Programming Approach for the Unequal Area Facility Layout Problem

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The Facility Layout Problem (FLP) is a classic problem for industrial engineers and work area designers. It is relevant because it directly impacts productivity and efficiency in productive systems. The FLP consists of locating a set of facilities (resources or entities that facilitate the performance of any job) to minimize the cost of satisfying a set of demands and accomplishing constraints related to the system's production [1]. We face the Unequal Area Facility Layout Problem (UA-FLP) when the departments may have different areas. UA-FLP is a complex problem with a wide range of applications; as a result, many authors have studied it [2]. In this research, we propose two mixed integer linear programming formulations for the UA-FLP and use them to solve some academic instances. In addition, we apply those models in a case study in which we relocated the departments in an SME of dairy products to make the company more profitable by minimizing the total cost of movements between areas. Through this case study, we find the supply chain to be an opportunity for any company to gain a strategic competitive advantage. UA-FLP seems to be not only present in the industrial sector but also in any other area where deciding objects' locations is required. For example, intelligent urban planning for sustainable development makes efficient use of energy in homes, hospitals, transportation services, markets, offices, and schools [3].

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Thau observer for Insulin estimation considering the effect of Beta-cells dynamics for a Diabetes Mellitus model

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Abstract

This research performs a mathematical analysis of a model that describes the dynamics between insulin levels and β cells in the presence of a glucose concentration [1] [2]. A nonlinear observer is designed based on the Lipschitz constant [3] and the compact invariant set location method [4]. Additionally, a closed-loop analysis is established to evaluate the feasibility of an immunotherapy treatment. Control inputs for insulin levels and glucose concentration are proposed to achieve asymptotic nonlinear dynamics stability [5]. Simulations are carried out using Matlab/Simulink. This research enhances existing knowledge by providing insights into the fluctuations of insulin levels over time at different glucose concentrations.

Keywords: Nonlinear Observer, LCIS, Mathematical Analysis, ODE Model.

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Feature extraction toolkit for multi-channel signal classification

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With the integration of sensors, smart devices and different machinery for capturing production-related information, the amount of data available for processes in an industrial setting is quite substantial. While this can be beneficial for building predictive models, it also poses a challenge for algorithms in identifying the data that can lead to highly performing models. In this sense, feature engineering has become a pivotal stage in the machine learning pipeline. This work describes Multi-channel Signal Tools [1], a Python-based framework for feature extraction from multi-channel signals. In this work we used the SEED_IV EEG dataset [2] as an example to demonstrate the functionality of the framework. This dataset is composed of electroencephalogram signals using 62 channels, and the data represents four different emotional states from the test subjects. After feature extraction, we implement an off-the-shelf algorithm to build a random forest model in a multi-class scenario. Despite utilizing data from only 12 EEG channels, the classifier achieves results comparable to more complex models using all 62 channels and eye movement data, highlighting the importance of effective feature engineering, and showing the efficiency of the proposed programming framework in optimizing multi-channel signal processing, enhancing scalability, and enabling insightful data analysis. These results indicate the potential of Multi-Channel Signal Tools in advancing feature extraction techniques and its possible impact across various fields.

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Optimization of Generalized Assignment Problem for a Machinery-Aided Composting Process

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Generalized assignment problem (GAP) is a recurring issue in both small and large companies. One of the strategies investigated to address this problem is the use of genetic algorithms. In this study, we focus on solving the "composting" problem, which involves optimally assigning M machines to N piles of different volumes over a 7-day work period. During this period, the piles must meet certain operational requirements, such as being turned on three times a week with a minimum of one day of rest between sessions. Two different experiments were carried out. In the first one, the number of piles varied from 20 to 44, increasing by 2 piles at a time. In the second one, three scenarios were proposed with different types of machines, which changed the operating cost but reduced the working time. The results demonstrate that genetic algorithms are a powerful tool for handling piles of different volumes, a common situation in the business environment. These algorithms provide superior results compared to other optimization methods, such as mixed-integer linear programming (MILP).

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Resolving Contrast and Detail Trade-Offs in Image Processing with Multi-Objective Optimization

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The trade-off between contrast and detail is a critical challenge in image processing. Enhancing contrast often leads to losing fine details, while preserving details can result in suboptimal contrast [2]. In this study, we address this trade-off using multi-objective optimization techniques to optimize both contrast and detail enhancement in images simultaneously. Two well-known multi-objective optimization algorithms, NSGA-II [1] and Goal Attainment [3], are employed to tackle this problem.
We evaluate the proposed techniques on various types of images, including medical, thermal, satellite, and natural scenes, demonstrating significant improvements in image quality as measured by objective metrics such as Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM). Our results indicate that the multi-objective optimization framework can effectively balance the trade-offs inherent in image processing tasks, providing a flexible and powerful tool for enhancing image quality. This work opens new avenues for applying bio-inspired algorithms to complex, real-world problems in image processing.

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Characterization and classification of Mexican woods by local texture analysis using deep learning techniques

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At present, thousands of tree species have been described in the planet where there are countries with great diversity, for this, their identification and classification is a concise activity for industrial, economic or environmental purposes. However, this task is done visually or chemically, depending on the skill and techniques of the specialist. We consider it urgent to have a tool to automate this task by means of recent pattern recognition and deep learning techniques. In this paper we present a comparison of two proposals for classification by means of artificial vision, using convolutional neural networks (CNN), and Transfer Learning with Fine-Tunning. We started from the use of the VGG16 network and our own database of images of 39 Mexican timber species that we are making available to the public. In the first experimental stage, 100% recognition was achieved for the resubstitution case, and 86% for cross-validation; but in the second experiment with the joint techniques, 96% accuracy was achieved.

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Analysis and characterization of digital images of land surface in the middle zone of the Mexican State of San Luis Potosi, by means of CBIR technique and evolutionary computation for fire risk assessment

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This paper presents a project for the recognition and classification of forest fires in multispectral satellite images, characterizing them, using the CBIR technique and a data augmentation based on the user's experience. The images are from the State of San Luis Potosi in Mexico, and the challenge is to present a first analysis and characterization with this type of images, to try to make a supervised classification of when a forest fire is present or not. We worked with a limited set of images and thanks to the proposed technique we were able to sufficiently characterize them. In a first experimentation with a distance classifier it was not possible to classify the images with fires, and in a second stage a genetic algorithm was developed and implemented to search for the most relevant bands, achieving a 100 % classification. The results shown here match the criteria of geographic specialists.

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Facial emotion recognition by means of convolutional neural networks for estimating ergonomic measures

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The facial reaction oriented to a representation of an emotion is an abstract task defined in the generality of the FER (Facial Emotion Recognition) concept, however, it is a complex task, since its interpretation is an abstract task and from computer vision and pattern recognition, a discrete approach is proposed. In this work we present the detection of 4 facial emotions: happiness, anger, neutral and sadness, by means of convolutional neural networks (CNN), with the aim of evaluating the ergonomics in video images of people working, in order to measure the well-being and health of people. The experiment was performed with videos recorded with good illumination and in an enclosed space, where the face can be detected head-on. A CNN with the Adam optimizer and ReLU is used to alleviate the leakage gradient problem, achieving 85 % recognition.

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Understanding the COVID-19 dynamics in Mexico trough mathematical modelling, biostatistics and *in silico* experimentation

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The spread of the SARS-CoV-2 in Mexico began with four confirmed cases of Mexican citizens who had recently traveled to Italy in February 2020. Then, the virus rapidly began to spread within the country infecting a total of 7,633,355 people by June 2023 from which 6,885,378 patients fully recovered and 334,336 died from COVID-19 [1]. Since the begging of the pandemic, different types of mathematical and computational models have been applied with the aim of forecasting either the contagion curve [2,3] or the total amount of deaths of a specific region [4,5]. In this work, we aim to understand the COVID-19 pandemic dynamics in Mexico by reconstructing the typical SIRD model [6] as a time-variant system of four nonlinear Ordinary Differential Equations as shown below:

$$\dot{S} = -\rho_1 S - I(\rho_2 S - \rho_3 t), \quad (1)$$
$$\dot{I} = \rho_4 S + I(\rho_5 S - \rho_6 t), \quad (2)$$
$$\dot{R} = \rho_7 I(R - \rho_8)^2, \quad (3)$$
$$\dot{D} = \rho_9 I(D - \rho_{10})^2, \quad (4)$$

where S(t) represents the susceptible population in Mexico, i.e., those who have not been infected with the virus, I(t) denotes the confirmed infected individuals which may develop the disease as asymptomatic, moderate, severe or critical, R(t) identifies the fully recovered patients, whereas D(t) follows the accumulated number of deaths from COVID-19. In Figure 1, we illustrate the relationships between the variables and provide additional information about the modelling assumptions. We were able to successfully fit Equations (1)-(4) by nonlinear regression to the data provided by the Government of Mexico on COVID-19 from February 2020 to June 2023 [1]. The algorithm was designed in MATLAB with the *fitnlm* function from the Statistics and Machine Learning Toolbox. The statistical significance of the results was established by analyzing the Standard Error, the 95% Confidence Intervals, and the p-value. The goodness of fit was evaluated quantitively with the R-squared and the Akaike Information Criterion, and qualitatively by means of *in silico* experimentation. Our mathematical model can accurately approximate the accumulated populations of susceptible people, infected individuals, recovered patients, and deaths from COVID-19.

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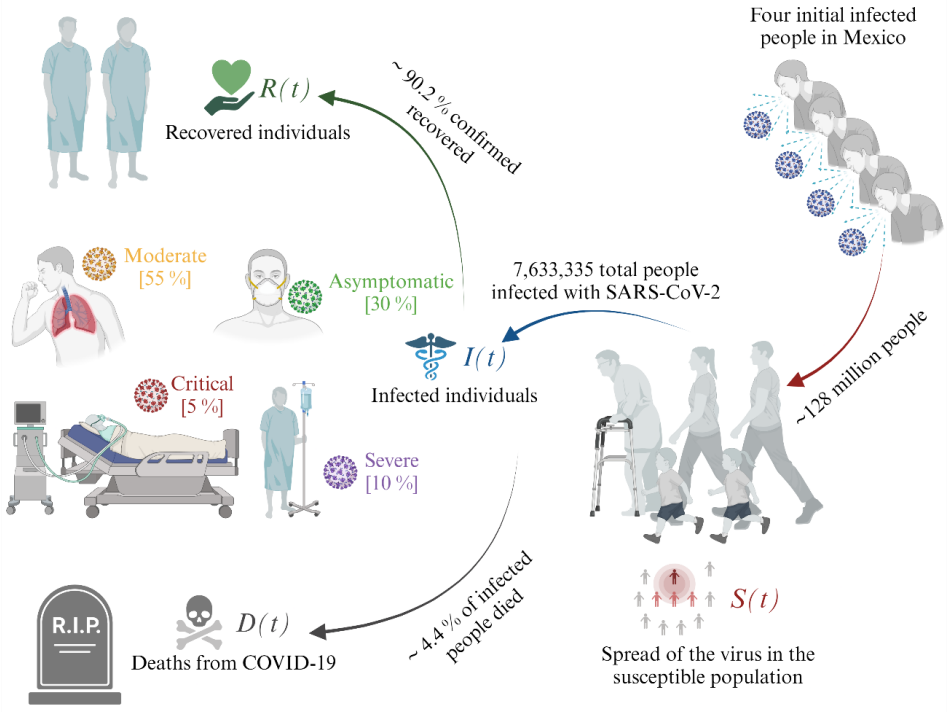

Figure 1. On February 2020 the INEGI estimated around 128 million people, which is considered as the Susceptible population in Mexico [S(t)], upon being infected by the SARS-CoV-2, individuals are then classified as Infected [I(t)] where the Health Secretary identified the following four possible scenarios: asymptomatic, moderate, severe, and critical. The latter two groups had mortality rates of 15% and 50%, respectively. After a certain period of time, patients could either recover [R(t)] from the disease and acquire a certain degree of immunity to the virus or pass away [D(t)]. The figure was created with BioRender.com under the agreement number KB273DQFU3.

Parameter estimation on *Kluyveromyces marxianus* strains through computational modelling and nonlinear regression

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Alcoholic fermentation is a biological process in which yeasts, in the absence of air, convert sugar into ethanol and carbon dioxide. It is used in industries to produce alcoholic beverages, bread, and vinegar. The growth of microorganisms directly influences the sensory characteristics of the final product, i.e., odor, flavor, and texture. On the other hand, the death rate or lifespan of the yeast allows for a better estimation of the shelf life of foods [1]. In this research, we developed and algorithm in MATLAB by applying the *nlinfit* function to estimate both the growth and death rates on different strains *K. marxianus* for ethanol production in batch fermentation [2,3]. Experimental data was measured from an alcoholic fermentation in batch culture where five strains were incubated in 20 g/L of yeast extract peptone dextrose agar at 30°C in order to study their kinetic growth. Fermentation was made in duplicate for every strain, samples were taken for 82 days and the average value of the two measurements was computed. The experimental data was segmented into two sets, the set with the initial data was applied to estimate the growth rate of each strain by fitting it to the logistic growth law defined by a first-order ordinary differential equation; whereas the second set allowed us to estimate the death rate of the strains by fitting the data to the exponential decay law (a first-order kinetics). We concluded that our results are statistically significant as the algorithm provides the standard error, the margin of error, the 95% confidence intervals, and the p-value [4]. Concerning the goodness of fit, two test were carried out to quantitatively determine the capacity of the models to describe the experimental data of the five *K. marxianus strains*: the coefficient of determination (R-squared) and the Akaike Information Criterion. The experimental data of biomass growth is illustrated in Figure 1.

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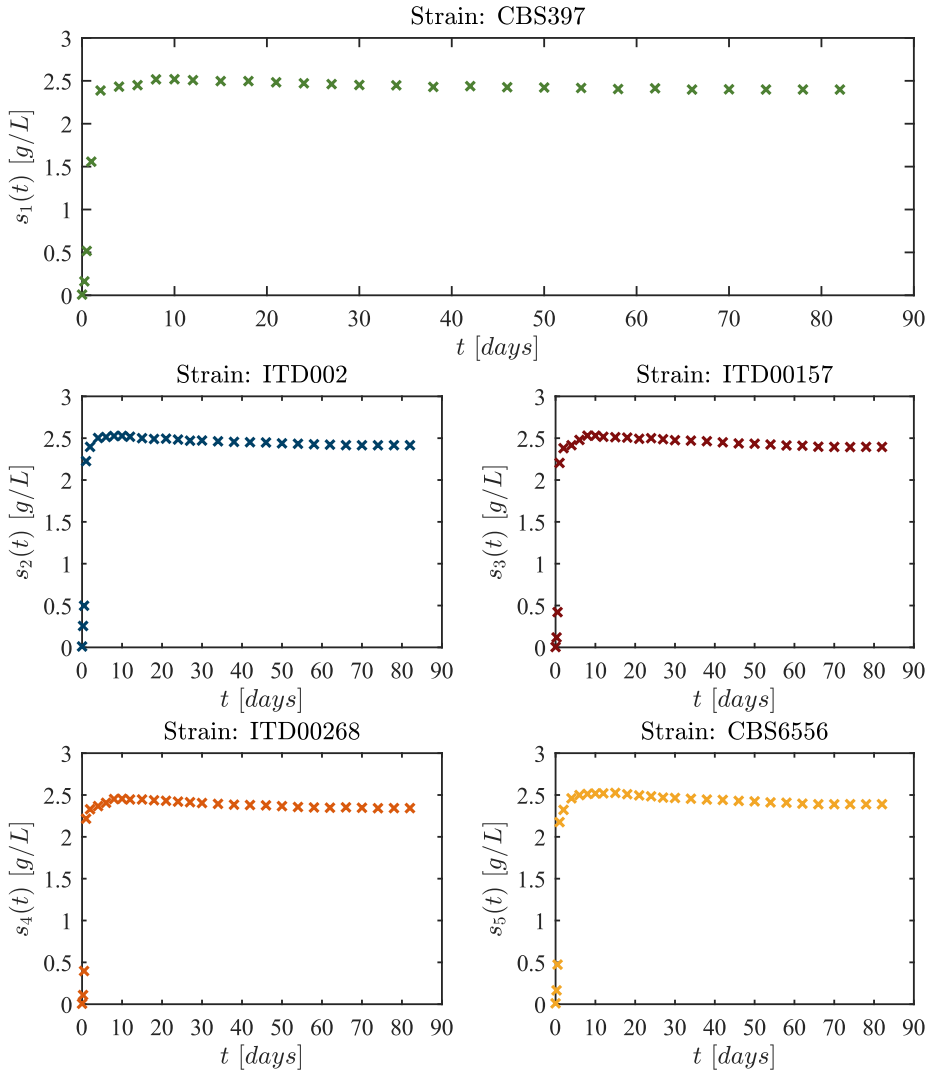

Figure 1. Experimental data for the biomass growth in the five strains of the *K. marxianus* yeast. This data is applied to estimate both the growth rate and the death rate of each strain through growth laws such as the logistic and the exponential decay by means of nonlinear regression and computational modelling.

Comparison of multi-objective evolutionary algorithms for fine-tuning a quantile forecasting deep neural network

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Recently, deep neural networks (DNN) have significantly impacted many real-world applications. However, typically, DNNs have a large amount of parameters to tune. This is further accentuated when considering multi-objective problems (MOP) where one would like to approximate a set of solutions, the so-called Pareto set. For instance, in finance, decision-making often involves multiple conflicting objectives, such as profit and risk. Recently, in [5], the authors compared the performance of NSGA-II [2] and NSGA-III [3, 4] to fine-tune a quantile forecasting DNN with two conflicting objectives: quantile coverage risk (QCR) and quantile estimation risk (QER), obtaining promising results. However, there are still many open questions on the scalability and performance of MOEAs for this task.
Thus, in this work, we perform a thorough study of the performance of classical EMO algorithms such as NSGA-II, NSGA-III, MOEA/D [6], and SMS-EMOA [1] to train DNN for financial forecasting. We tested with DNNs ranging from 387 to $536,963$ parameters. Further, we compared the algorithms on the Hypervolume indicator and used a series of uniform weighted sums as control. Our results show that EMO algorithms are able to achieve similar results to the weighted sum approach and with better distributions than the weighted sum.

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Hypervolume Gradient Subspace Approximation

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Multi-objective evolutionary algorithms (MOEAs) are powerful optimizers that are capable of solving black-box multi-objective optimization problems. Due to their stochastic nature, local search methods, including directed search algorithms, have been proposed to guide search directions in the decision variable space. In particular, recent studies have shown that the inclusion of local hypervolume-based gradient methods can lead to better convergence rates. In this work, a set-based method of estimating hypervolume gradients without additional function evaluations or Jacobian information is proposed and integrated with SMS-EMOA to form a steady-state MOEA. The proposed algorithm is compared to some widely-used MOEAs on two- and three-objective benchmark suites, outperforming all other algorithms on all 6/6 two-objective problems and 12/17 three-objective problems.

New Metaheuristics to Solve the Internet Shopping Optimization Problem with Sensitive Prices

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In this research work, two new solution methods to the Internet shopping optimization problem with sensitive prices (IShOPwD) are proposed that incorporate adaptive adjustment of control parameters, as has been previously demonstrated in the state-of-the-art this problem is classified as NP-hard type and has great relevance in current electronic commerce. The first proposed solution method corresponds to a memetic algorithm (MAIShOPwD) incorporating improved local search and adaptive adjustment of control parameters. The second proposed solution method is a particle swarm optimization algorithm (PSOIShOPwD) that adds a technique diversification and adaptive adjustment of control parameters. Assess the effectiveness of the proposed algorithms by comparing them against the branch and bound (BB) algorithm, which presents the most favorable outcomes of the state-of-the-art method. Nine instances of three different sizes were used: small, medium, and large. For performance validation, the Wilcoxon and Friedman nonparametric tests were applied. The results showed that the proposed algorithms exhibit comparable performance and outperform the BB algorithm.

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**Classification of scientific texts via support vector machines.
Case study texts on cybersecurity 2018 to 2023**

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Text classification involves identifying and categorizing texts into distinct groups or classes. This process is crucial in various fields, particularly in cybersecurity, where it helps detect online threats such as spam, malware, and intrusion events, as well as analyze network traffic behavior. In this study, a scientometric analysis is performed on cybersecurity articles to classify them and identify common elements from these classifications. The objective is to uncover patterns and trends within the cybersecurity domain that can enhance threat detection and response strategies. The analysis leverages complex networks, providing a deeper understanding of the relationships and structures within the data. This proposal achieves a rating of over 90 %.

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A real-world dataset for analyzing cultured fish behavior

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Monitoring fish behavior through artificial vision systems has emerged as a highly effective tool in optimizing aquaculture production systems [1]. Numerous studies have demonstrated the feasibility of recognizing specific behavioral patterns in fish, facilitating improved management and productivity [1][2]. However, most of these studies are conducted under ideal laboratory conditions with controlled variables and optimal image clarity. These ideal conditions do not mirror the practical realities of aquaculture environments, which often lack optimal lighting and are challenged by the presence of various organisms and waste products from the farming process [2][3].

Stress in fish is a critical factor that affects their growth, reproduction, and overall health [4]. Stress can be induced by various environmental factors, including poor water quality, overcrowding, and handling practices [5]. Consequently, monitoring stress levels is essential to ensure the optimal well-being and productivity of fish in aquaculture systems. Artificial vision systems can play a significant role in detecting signs of stress. To address this gap, an extensive database of images and videos captured under real-world farming conditions has been developed.

This database considers various potential variables that might limit the effectiveness of underwater artificial vision systems, helping to establish practical guidelines and technological requirements for effective fish monitoring. Enriched with measurements of critical water quality variables. Understanding these limitations and the actual conditions under which fish are raised ensures that the monitoring systems are both practical and reliable.

The insights gained from this research will be instrumental in developing more robust, adaptable, and effective monitoring systems that can significantly enhance productivity and sustainability in aquaculture.

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Lightly robust solutions for MOGenConVRP under uncertainty

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In multi-objective optimization, we typically do not consider how uncertainties may impact the performance of the solutions found. However, this is highly important when considering real-world problems. Since, we need to find solutions that perform well despite uncertainties. For instance, in the Multi-objective Generalized Consistent Vehicle Routing Problem (MOGenConVRP) [3], uncertainty comes from the frequency of the visits to each customer. In this problem, we need to plan the routes to service customers either in the mornings or afternoons over a fixed time period to minimize the total time of the tour, the maximum number of different drivers that visit any customer, and the maximum arrival time difference.

To address this problem, we propose to adapt the Cooperative Multi-Indicator Based Ant Colony Optimization algorithm (cMIBACO) [5] to search for lightly robust solutions [2]. This algorithm is based on the use of performance indicators based ant colony optimization [4] and the combination of quality indicators [1]. In particular, our approach uses multiple colonies based on a distinct quality indicator (Hypervolume, epsilon and R2). After each colony creates multiple solutions, we perform a migration process where solutions are selected to update the matrix pheromone of another colony. Further, the algorithm includes components of local search and genetic operators to improve its search capabilities.

We applied the cMIBACO for the MOGenConVRP under uncertainty to find lightly robust solutions to benchmark problems. Our results show that cMIBACO performs competitively against the individual indicators and the weighted sum.

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Expected Hypervolume Improvement for Multiobjective Reinforcement Learning

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In the real world, most problems require consideration of multiple objectives, which often conflict with each other. Further, it is commonly the case that we have a series of decisions rather than just one. This setting leads to the so-called multi-objective reinforcement learning. In this kind of problems agents aim to learn a set of policies that simultaneously optimize multiple reward criteria provided by the environment.

In recent years, the community has increasingly paid attention to these problems; however, the necessity for more effective solutions persists. In this context, we propose adapting the Pareto Q-learning algorithm with tools from multi-objective evolutionary algorithms and Bayesian optimization. In particular, our algorithm leverages the hypervolume of generated policies to guide the search, using the expected hypervolume improvement (EHVI) criterion. EHVI calculates the expected increase in hypervolume indicator, considering an approximation set of the Pareto front and a multivariate Gaussian distribution at a new point. The purpose is to guide action selection towards those with a higher expected contribution. EHVI allows an effective method to compute a policy and balance exploration and exploitation.

The algorithm has demonstrated strong performance in discrete environments with 2 and more objectives, provided by MO-Gymnasium, proving to be as competitive as other state-of-the-art algorithms. Future work aims to extend the EHVI approach to continuous environments by employing exploration techniques directly within policy parameterization.

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When does weighted sum perform well on multi-task learning?

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Multi-task learning (MTL) involves training models for multiple tasks simultaneously, which has shown to accelerate training and improve generalization. MTL is essentially a multi-objective optimization (MOO) problem where multiple loss functions need to be minimized simultaneously. To address this problem, various MOO methods have been explored [1, 2]. Among MOO methods, the weighted sum has received the most attention due to its wide success and simplicity [2, 1]. In the machine learning literature, a unified objective function for MTL is constructed by weighting the empirical loss over all tasks through weights. This is defined formally as follows: $\min_{\mathbf{x}\in\mathbb{R}^n} \sum_{i=1}^{k} w_i L_i(\mathbf{x})$, where $w_i \geq 0$, $\sum_{i=1}^{k} w_i = 1$ are the weights, $L_i(\mathbf{x}) : \mathbb{R}^d \to \mathbb{R}$ is the loss of the i-th task for all $i \in \{1, \ldots, k\}$, d is the number of parameters in the model, and k is the number of tasks (or objectives). However, the performance of multi-task networks trained using this technique has sparked debate in the literature. While some works have shown that multi-task networks trained using scalarization outperform task-independent models [2, 3], others suggest the opposite [1, 4]. As a result, many explanations have been proposed for the difficulty of MTL, each motivating a new Specialized Multi-Task Optimizer (SMTO) [1, 5, 6]. While SMTOs often claim superior performance over weighted sum, they require costly per-task gradients, increasing computation and memory costs. In contrast, unitary scalarization is more efficient, needing only the average gradients, computed via a single backpropagation [2]. However, the weighted sum method can find every point on a local Pareto front only if the front is convex, which is generally not true. This study investigates the performance of the weighted sum method in MTL using standard multi-task vision datasets. We analyze different performance indicators to highlight the effectiveness of the weighted sum for MTL. Our preliminary findings reveal that the Pareto fronts are highly convex for the classical test problems, which can explain the approach's success even when compared to more complex methods.

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Online Selection of Mutation Operators for the Grouping Genetic Algorithm with Controlled Gene Transmission for the Bin Packing Problem

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The One-Dimensional Bin Packing Problem (1D-BPP) has garnered extensive attention over the last few decades due to its wide range of applications. Given its complexity, various techniques have been employed to tackle this problem, with metaheuristics and hybrid algorithms standing out for their performance. Among these, the Grouping Genetic Algorithm with Controlled Gene Transmission (GGA-CGT)) [1] has distinguished itself in the state-of-the-art, surpassing other leading algorithms in optimally solving high-difficulty benchmarks.
Building on previous studies, the algorithmic behavior and performance of GGA-CGT have been further analyzed [2, 3]. It has been observed that the sequence in which genes are processed when applying GGA-CGT's genetic operators significantly influences its performance. This research presents a study exploring techniques to enhance the impact of the mutation operator on GGA-CGT's performance. These techniques involve controlling categorical parameters [4] that dictate the type of gene ordering before mutation, which can either be random or in descending order of gene filling. This selection is performed online, using population diversity as feedback to determine the mutation operator for each generation.
The results demonstrate that online control of gene ordering substantially improves the algorithm's performance, increasing the number of optima obtained from the test benchmark. Furthermore, this approach promotes diversity and provides valuable insights into studying this phenomenon. Lastly, areas of opportunity were identified in controlling these parameters, offering potential for further improvements in algorithmic performance.

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Consistent Conjectural Variations Equilibrium for a Human Migration Model

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Human migration issues have been actively studied in many countries around the world, as predictive data are extremely useful on a large economic scale. Migration prediction data can guide the development of necessary facilities to promote employment, education, and ecology. Conversely, places with more advanced infrastructure, greater employment capacity, and environmentally friendly conditions can attract more potential migrants by fostering the preference of residents. However, overloaded housing/infrastructure can reduce daily comfort, thereby contradicting Kansei engineering principles. Our objective is to extend the concept of conjectural variations for the human migration model. To achieve this, we first present the standard multiclass human migration network equilibrium model proposed in [2] that describes the movement of migrants between locations. Next, we introduce the concept of conjectural variations (see, [1]), where migrants conjecture the (expected) utility of locations after their movement. We define the notion of conjectural variations equilibrium and provide results regarding the conditions for its existence and uniqueness. Finally, we address the concept of consistency for migrants' conjectures and the consistent conjectural variations equilibrium (CCVE).

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Multi-Objective Harmony Search Algorithm with Improved Harmony Creation

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This work proposes a new, improved, and adapted version of the Harmony Search algorithm to solve multi-objective dynamic problems, which we call MOHSi. The main feature of this algorithm lies in the mechanism for creating new harmonies; with ζ percent, the mechanism will assign notes from an existing harmony in the harmony memory to the new harmony, and with η percent, the note assigned to the new harmony will be generated by crossing any two harmonies contained in the harmony memory using an adapted version of the SBX operator, and with θ percent the note will be generated completely randomly. This update in the mechanism allows the algorithm to have a better balance between Exploration and Exploitation. On the other hand, the bandwidth value is readjusted in each iteration through a linear reduction, which allows the degree of exploration and exploitation not to be fixed and helps the algorithm to find higher-quality solutions. The Harmony Search algorithm was initially designed to solve single-objective problems. To allow this algorithm to be applied to multi-objective problems, non-dominated sorting and crowding distance sorting were added. These techniques were applied to harmony memory to rule out the worst solutions. MOHSi was tested through extensive computational experimentation, and its results were compared with those of the MOEA/D and MOEA/D-QL algorithms. Three evaluation metrics were used: hypervolume, generalized spread, and inverted generation distance. In addition, the non-parametric statistical tests of Wilcoxon and Friedman were applied with a statistical reliability of 95%; the results obtained suggest that the solutions produced by the proposed MOHSi algorithm are statistically superior to the MOEA/D algorithm and concerning the state-of-the-art algorithm MOEA/D-QL present a similar performance.

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Improving wind speed forecasts in the state of Michoacan through dynamical downscaling

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In recent years, wind power has experienced significant growth both in Mexico and globally. In 2022, Mexico's installed wind power capacity stood at 6.977 GW, representing 8.1% of the overall installed power capacity [1], presenting a promising future for wind energy in the country. To facilitate the integration of a higher proportion of wind power into the power system, it is imperative to enhance the accuracy of wind speed forecasting.

This study leverages the advanced capabilities of the Weather Research and Forecasting (WRF) model to conduct dynamic downscaling aimed at improving wind speed forecasts in Michoacán state. Dynamical downscaling involves using data from a global model to create a high-resolution model for a specific region, transferring the effects of large-scale climate processes to local areas. This approach, using finer resolutions, is advantageous for representing the regional variability of wind speed influenced by factors such as complex terrain.

The resulting domain, with a resolution of 2 km, covers the entire state of Michoacán and integrates land use data from the Instituto Nacional de Estadística, Geografía e Informática (INEGI) into the model configuration. To ensure the reliability of our findings, wind speed data from four meteorological stations were used to validate the wind speed forecast model for a four-day ahead forecast. The 2 km downscaling model demonstrates improved wind speed forecast accuracy of up to 70% compared to wind speed forecasts from an 18 km resolution WRF model with Mexico as the domain.

Keywords: Wind energy, wind speed forecast, WRF.

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Evaluation of Machine Learning Methods for Temperature Prediction in Mexican Regions

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Regionalized forecast is used here in the climate change framework to evaluate one or more associated variables in different regions of a specific country, area, or zone of the planet; this is a crucial task for understanding and mitigating the climate change effect at the local level. This approach allows adapting response strategies to the specific conditions of each region. This paper addresses temperature prediction as a relevant variable in climate change; besides, we present a comparison of the predictions made with classical and machine learning methods to evaluate their accuracy in predicting temperature in Mexico. The temperature projections obtained can be used to generate climate change scenarios and assess possible future impacts. These predictions are also helpful for developing mitigation strategies. The climatic diversity in Mexico requires adapting models to the specific characteristics of each region, where the integration of historical data, statistical models, and simulations is essential to improve the accuracy and relevance of climate forecasts in the Mexican country.

Key Words: Classical Forecasting Methods, Machine Learning, Climate Change, Temperature Prediction, Evaluation Forecasting Methods, Time Series.

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An Enhanced Image Segmentation Algorithm Inspired by Mean Shift and Particle Swarm Optimization

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Image segmentation is the fundamental basis of image analysis, in which a digital image is partitioned (i.e. segmented) into distinct sets of pixels that share local characteristics, such as intensity, color, or texture. The techniques for performing such partitioning can be classified into threshold-based, edge-based, and region-based segmentation methods. There are some region-based hybrid techniques that allow multilevel segmentation instead of binary segmentation at the cost of exponentially increasing their computational complexity as the Mean Shift segmentation technique [1, 2]. Also, determining appropriate values for their parameters can be non-trivial, so they have limitations. In this work, we propose a novel multilevel image segmentation algorithm that does not rely on a fixed predefined number of segments but rather enables the definition of the desired level of detail by means of a single parameter called the spatial variation range. Our algorithm first partitions its input image into a grid with N cells; then, it analyzes each cell using a metaheuristic method based on the Particle Swarm Optimization (PSO) algorithm, which does not search for the best global solution. Instead, each swarm (one for each grid cell) moves over the two-dimensional pixel space in the image, searching for high-density colors that may be representative of the largest possible pixel neighborhood within the cell boundaries. Then, the colors found are clustered and simplified, both at the neighborhood and cell levels. Finally, the results obtained by all swarms are simplified globally, and the resulting color set is used to replace the color of each pixel in the original image with its closest match in the set, thus generating the segmented image. The proposed algorithm was tested on some images of the COCO (Common Object in Context) data set [3]. Our preliminary results show that this method effectively identifies the main objects and enhances their uniformity within the images, achieving processing times equal to or better than the Fast Fuzzy C-Means Clustering for Image Segmentation algorithm (SFFCM) [4].

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Optimizing Recoverable Robustness of Power Distribution Networks

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Power distribution networks (PDNs) are crucial to infrastructure, providing reliable electricity to essential services. Disruptions, such as natural events or malicious attacks, can significantly impact these networks. Traditional resilience strategies often focus on robust infrastructure design, but operational strategies like recovery robustness, which involve quick restoration, e.g. through optimal switch reconfiguration [4], offer additional protection.

Recoverable robustness optimization not only evaluates the state of a network or schedule immediately following a disruption but also after the implementation of swift and cost-effective restoration measures. It originated within the context of railway systems [3] and has recently received attention in other areas, such as airline delay management and timetabling [1, 2].

This paper presents the concept of recoverable robustness in the context of PDNs to evaluate the best reinforcement strategies for networks, considering the potential for quick service restoration following disruptions. Through simulations on the IEEE69 network, we demonstrate that optimal switch reconfigurations can re-establish connectivity and reduce power losses, with special attention to critical nodes. Our assessment criteria include the number of disconnected nodes, total power loss, and voltage deviations.

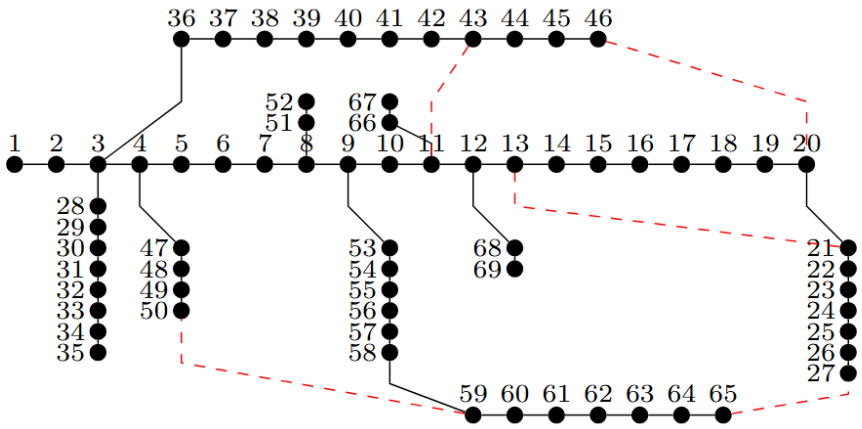

Figure 1: IEEE 69 Bus System. Nodes represent power hubs or demand points. They are connected by power lines (black). Red dashed lines show open switches that can be closed to restore power. The PDN must form a tree to prevent short circuits and connect all nodes to a generator, e.g., node 1.

Our findings, demonstrated on the IEEE69 Bus System, highlight that recovery robustness can significantly enhance PDN resilience. The proposed method efficiently restores service, ensuring minimal impact on system stability and reliability. This approach can be extended to larger-scale networks, offering a scalable solution for maintaining critical infrastructure during and after disruptions.

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Validation of wind speed forecasts developed with the Weather Research and Forecasting model

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The accuracy and reliability of meteorological forecasts are essential for decision-making in various sectors, from agriculture to disaster management. The Weather Research and Forecasting (WRF) model has established itself as a crucial tool in meteorological prediction, offering a flexible and accessible platform for simulating atmospheric phenomena across different scales. However, to ensure the quality of its predictions, it is essential to conduct a rigorous validation process for the generated models.

For wind speed forecasts, model validation is typically carried out using error metrics to meticulously compare the proposed dataset with real observational data. However, this research adds an additional validation technique to the commonly used methods for wind speed forecasts.

In this study, the sensitivity of wind predictions generated by the WRF meteorological modeling system, which utilized reanalysis data from the National Center for Atmospheric Research (NCAR), observational data from NASA's world energy resources, and observational data from NASA Giovanni, was evaluated. The WRF model predictions were compared with observational data from the site La Mata, located in the municipality of Asunción Ixtaltepec, Oaxaca, Mexico. A qualitative and quantitative analysis of wind speed behavior at 10 meters above ground level was conducted. Qualitative validation was performed using data provided by the NASA Giovanni platform, while quantitative validation employed error metrics such as Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Anomaly Correlation Coefficient (ACC).

The results indicate that qualitative and quantitative validation provides a more comprehensive and accurate view of the effectiveness of the WRF model in predicting wind speed, offering a more integral perspective on the model's accuracy.

Keywords: WRF, forecast model validation, wind speed prediction, error metrics.

On the Effect of Temporal Heterogeneity on Selection Pressure of Evolutionary Algorithms

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The balance between exploration and exploitation is a critical aspect of evolutionary algorithms (EAs), often disrupted by highly elitist strategies, leading to reduced population diversity and the potential omission of promising solutions. To address this, some researchers have examined the impact of different selection strategies and operators [1, 2]. However, this is typically done for simplified algorithms or problems.

In this work, we propose studying temporal heterogeneity, which balances exploration and exploitation dynamically. We conducted a comprehensive empirical evaluation using genetic algorithms, differential evolution, and evolutionary strategies on the BBOB test suite for single-objective optimization, as well as NSGA-II and NSGA-III on the BiBBOB and WFG test suites for multi-objective optimization (a preliminary study can be found in [3]). Our results show that temporal heterogeneity significantly influences EA performance, particularly in high-dimensional spaces, with moderate values of H (approximately 0.5) enhancing performance in single-objective scenarios and higher H values improving convergence in multi-objective settings. These findings were validated for statistical significance.

Additionally, we developed a machine learning model based on exploratory landscape analysis (ELA) features to predict optimal heterogeneity values, with SHAP analysis providing insights into the problem characteristics that drive the effectiveness of heterogeneity. This study highlights the potential of temporal heterogeneity in improving EA performance and lays the groundwork for adaptive strategies that dynamically adjust selection pressure during algorithm execution. Future research will extend these mechanisms to more complex multi-objective problems and integrate external archives [4].

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Evolutionary algorithm and EEG classification for the detection of mental states

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The objective of this work is to develop a method that is able to automatically determine mental states of vigilance; i.e., a person's state of alertness. Such a task is relevant to diverse domains, where a person is expected or required to be in a particular state of mind. For instance, pilots and medical staff are expected to be in a highly alert state and the proposed method could help to detect possible deviations from this expected state. This work poses a binary classification problem where the goal is to distinguish between a "relaxed" state and a baseline state ("normal") from the study of electroencephalographic signals (EEG) collected with a small number of electrodes. The EEG of 58 subjects in the two alertness states (116 records) were collected via a cap with 58 electrodes. After a data validation step, 19 subjects were retained for further analysis. An evolutionary algorithm was used to select a subset of electrodes. Even if the present approach is costly in computation time (GA search), it allows to construct a decision rule that provides an accurate and fast prediction of the alertness state of an unseen individual.

Fuzzy Grammatical Evolution

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Abstract

Fuzzy grammatical evolution (FGE) [1-3] is a hybrid system, where on the one hand grammatical evolution is a variant of genetic programming that allows a clear distinction between genotype and phenotype in the evolutionary process and on the other hand, fuzzy logic deals with uncertain data through linguistic variables that are more understandable for humans. Real-valued data is converted, in a first step, from crisp data to fuzzy data, then FGE develops a set of fuzzy tree classifiers better known as fuzzy pattern trees, the resulting system increases its interpretability with competent results against the top current methods.

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A preliminary study of Collaborative Multi-objective Multi-agent Systems by means of SAC and PPO

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In many complex problems, collaboration among multiple agents is essential to achieve a common goal. This structure is commonly known as collaborative multi-agent systems [1, 2]. The rise of deep reinforcement learning (DRL), i.e., the combination of deep learning and reinforcement learning, has allowed agents to go further in the environment where they can learn. Many real-world problems can be modeled as a multi-agent reinforcement learning problem (MARL), and the emergence of DRL has enabled researchers to move from simple representations to more realistic and complex environments [2].

Before the existence of DRL techniques, due to the so-called 'curse of dimensionality', the agents could only learn in limited environments where the observation and action spaces had to be discrete. For this reason, deep multi-agent Reinforcement Learning algorithms have been gaining attention [3]. On the other hand, there are still several challenges that remain predominantly unsolved: Computational complexity, nonstationarity, partial observability, and credit assignment [2]. Despite the fact that many real-world problems are inherently multi-objective, the majority of multi-agent systems implementations aim to optimize the agent's policies with respect to a single objective [4].

In this work, we extend reinforcement learning algorithms to a multi-agent environment by incorporating a shared critic, adapted from multi-agent deep deterministic policy gradient (MADDPG). Specifically, we implement both soft actor-Critic (SAC) and proximal policy optimization (PPO) algorithms with a shared critic to explore how each handles multi-objective rewards. Our approach involves scalarizing rewards into a unified signal to simplify the problem. Through this setup, we aim to highlight the challenges and computational demands of managing multiple objectives in multi-agent environments. By showcasing the performance of SAC and PPO in this context, we provide insights into the difficulties of multi-objective optimization and the effectiveness of different algorithms in addressing these complexities.

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Multiclass Evaluation of Vision Transformers for Industrial Defect Detection

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This study offers a detailed evaluation of Vision Transformers (ViT) for automated defect detection and classification in aluminum welding. The research specifically applies a single ViT model to the Aluminium 5083 TIG dataset, addressing both a binary task for detecting the presence of welding failures and a multiclass problem for identifying the type of defect (Good weld, Burn through, Contamination, Lack of fusion, Misalignment, Lack of penetration). Additionally, the study assesses the model's effectiveness and adaptability in identifying conspicuous defects across different material contexts. The dataset was rigorously preprocessed and standardized to ensure compatibility with the ViT architecture, enabling a fair and consistent evaluation. Our findings demonstrate that the Vision Transformer model achieves high accuracy across all tested datasets, indicating strong generalization capabilities. The results suggest that Vision Transformers are not only effective but also versatile tools for industrial defect detection, providing reliable performance across different material types without the need for model reconfiguration. These insights contribute to the broader understanding of how Vision Transformers can be utilized in industrial quality control, offering a promising approach for automating defect detection processes in manufacturing.

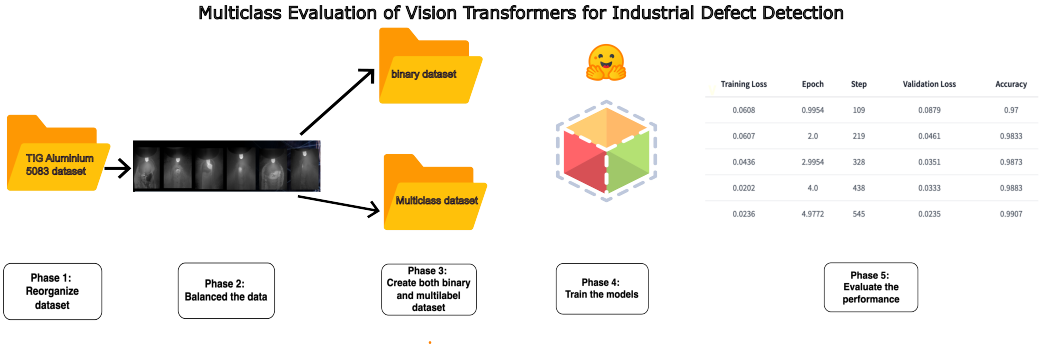

Figure 1: Visual Abstract

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Exploring the Synergy between M3GP and t-SNE for Enhanced Multiclass Classification

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Multidimensional Multiclass Genetic Programming with Multidimensional populations (M3GP) is a powerful tool for multiclass classification, thanks to its ability to generate complex, high-dimensional feature representations. However, the challenge of visualizing and interpreting these multidimensional features persists. In this study, we investigate the potential of combining M3GP with t-Distributed Stochastic Neighbor Embedding (t-SNE), a popular dimensionality reduction technique, to improve classification outcomes.

Our approach involves using M3GP to generate a high-dimensional feature space, which is then transformed by t-SNE into a lower-dimensional representation. This transformation aims to preserve the local and global structure of the data while making the classification task more tractable. We assess the performance of this combined method across various datasets, comparing it with traditional M3GP and other state-of-the-art classification techniques.

Preliminary results indicate that the integration of t-SNE with M3GP not only enhances the interpretability of the feature space but also improves classification accuracy. This synergy between M3GP and t-SNE opens new avenues for applying genetic programming to complex classification problems where both accuracy and interpretability are critical.

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Preliminary Exploration of Hyperparameter Tuning in Superiorization Technique

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The superiorization technique is used to enhance the solutions of iterative algorithms, such as the Algebraic Reconstruction Techniques (ART), in medical image reconstruction [1]. This process involves introducing iterative perturbations that adhere to the problem's constraints with the goal of minimizing a second optimization criterion known as Total Variation (TV) [2]. Two key hyperparameters in this context are the step size and the decay factor, whose initial determination is a complex, context-dependent task that is addressed as an optimization problem. In this work, we present a preliminary effort to explore the solution landscape for this problem [3]. The strategy employed involves performing a greedy search starting from ten distinct points within the permissible ranges of the hyperparameters. The experiments were conducted using a synthetic image (phantom) that is based on an actual cross section of the human head. Our results indicate that a step size close to 1, combined with a low decay factor, yields the best image reconstruction quality, while higher decay factors result in suboptimal solutions, regardless of the step size. This work allows an initial analysis of the relationship between the hyperparameters and the reconstruction produced with the superiorization method. In future work, numerical and evolutionary methods will be used to facilitate the identification of optimal and robust configurations in the superiorization algorithms [4]. This approach is expected to ultimately contribute to improving the quality of image reconstructions, even when a small number of projections are available.

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Swarm-Based Training to Optimize Hyperparameters in Reinforcement Learning Environments

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Automated Reinforcement Learning (AutoRL) provides a unified framework integrating neural network training with hyperparameter optimization. The predominant methodologies in AutoRL [1] include random search [2], Bayesian optimization [3], evolutionary strategies [4], and Population-Based Training (PBT) [5]. PBT is particularly effective in addressing the non-stationarity inherent in reinforcement learning problems [6] by generating a dynamic hyperparameter schedule within a single training run. However, PBT is constrained by its inability to facilitate information exchange between agents [7] [8], thereby limiting the comprehensive utilization of insights derived from individual trials.
This work introduces Swarm-Based Training (SBT), a method designed for scaling and managing PBT subpopulations by incorporating the multi-quantum swarm model [9] as an interaction mechanism and leveraging trial information between swarms for resource allocation.
To evaluate our approach, we optimize the hyperparameters of the Proximal Policy Optimization (PPO) algorithm [10]. Specifically, we fine-tune the learning rate, clipping parameter ϵ, GAE λ, and batch size across three OpenAI Gymnasium control environments: LunarLanderContinuous, BipedalWalker, and Pendulum.
The results were benchmarked against random search and standard PBT, indicating that SBT offers an advantage in solving reinforcement learning problems by enabling information exchange between agents and efficiently managing computational resources.

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A Novel Framework for Multi-objective Evolutionary Algorithms by Means of Hausdorff Approximations

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In many applications, one is faced with the problem of optimizing several objectives concurrently. One important characteristic of multi-objective optimization problems (MOPs) is that the solution is not one single solution, as for single objective optimization, but an entire set of solutions is called the Pareto set. More precisely, one can expect that the Pareto set of continuous MOPs forms at least locally a manifold of dimension k-1, where k is the number of objectives considered in the problem.

Multi-objective evolutionary algorithms (MOEAs) have been successfully applied to the numerical treatment of MOPs over the last three decades. One important task within MOEAs is the archiving (or selection) of the computed candidate solutions, among others, due to the cardinality of the Pareto set. However, most MOEAs only converge on the limit if equipped with external archives [1, 2]. This approach has disadvantages since MOEAs with external archivers have two populations and two selection strategies, which comes with an extra computational cost.

In this work, we present and analyze a novel framework for $\mu + 1$ MOEAs that aims to achieve Hasudorff approximations of the Pareto front. The framework uses the inclusion mechanism of ArchiveUpdateHD, a bounded archiver that aims for Haussforff approximations [3]. At the same time, it uses typical approaches of MOEAs as the exclusion criteria for the selection. The algorithm has the advantage of a quasi-monotonic behaviour while having only one population. Finally, we tested the approach on several well-known academic test problems for two and three objectives and compared the framework with three widely used MOEAs (NSGA-II, SMS-EMOA, and MOEA/D). Our results indicate that the novel strategy is beneficial when measured by classical performance indicators.

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Hypervolume Indicator gradient and Hessian: Analytical Expressions and Algorithms

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The problem of approximating the Pareto front of a multiobjective optimization problem (MOP) can be reformulated as the problem of finding a set that maximizes the hypervolume indicator. We can derive the analytical expression of the gradient and the Hessian for objective functions that are twice differentiable [DEW22], which enables fast numerical optimization methods for MOPs. This talk establishes the analytical expression of the gradient and the Hessian matrix of the mapping from a (fixed size) collection of n points in the d-dimensional decision space (or m dimensional objective space) to the scalar hypervolume indicator value.
This talk will cover the full expression for arbitrary dimensions ($m \geq 2$ objective functions), for which a compact recursive analytical expression is established, and its algorithmic implementation is discussed.
The hypervolume indicator gradient is essential to define the steepest ascent method for MOPs [WDBE17]. The Hessian matrix plays a crucial role in second-order methods, such as the Newton-Raphson method. We will illustrate the Hypervolume gradient and Newton Method (HVN) [SSW$^+$20], which is a fast and precise indicator-based local search method and its extension to constrained MOPs [WED$^+$23]. Furthermore, we will demonstrate the applicability of the HVN method as a standalone method or when hybridized with multiobjective optimization evolutionary algorithms (MOEAs).

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TaePredict to Forecasting Time Series based on Threshold Accepting Algorithms

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Abstract

Time series are commonly used in forecasting problems, and one of the best strategies is to ensemble machine learning and statistical or classical methods. An ensemble is a combination of methods with different approaches, combining the results of the best methods and weighing them with a measure of their quality predictions. A sophisticated alternative to obtain the best combination weights is to apply a Montecarlo method, which uses the Boltzmann distribution. Nevertheless, the previous alternative could have a high computational cost, and these methods lack simplicity, are far-fetched, and are quite cumbersome for many researchers. TaePredict is a Montecarlo method proposed in this work, with a similar quality to Boltzmann methods, because it emulates this distribution with a simple heuristic and establishes simple rules to enhance the forecasting of the ensemble. We present this new ensemble forecasting method's foundations, algorithms, and applications.

Keywords: Threshold algorithms, Ensemble methods, Machine learning, forecasting, Classical and statistical methods.

YOLO versions analysis for detection of types and subtypes in images

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Detection and classification objects in images are essential tasks in computer vision, with applications covering surveillance control, industrial processes, object tracking, image processing, robotics, and object recognition. Advances in this field could significantly improve the efficiency and effectiveness of many technologies. The YOLO (You Only Look Once) family models have proven to be a promising solution due to their ability to perform fast and accurate detections. YOLO has evolved significantly, with each new version offering improvements in performance and efficiency. In this work, we provide a comparative analysis of the YOLOv5 to YOLOv10 and their different models (n, s, m, l, x). The analysis focuses on evaluating the performance of these models using the metrics such as training time, accuracy, recall, and mAP. To evaluate these models, a data set of 2,000 images was used, classified into five main types: dog, cat, plant, fruit, and bird, where each type includes subtypes. The best performance in this analysis was obtained by YOLOv10, using the data set proposed.

Keywords: YOLO, Computer Vision, Object Detection, Image Classification, Deep Learning.

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