

Josefa Díaz Álvarez

Senior Lecturer

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Curriculum summary

Holds a degree in Computer Engineering and a Master's Degree in Research in Engineering and Architecture. She has been a faculty member at the Universidad de Extremadura since October 2001, based at the Centro Universitario de Mérida. Over the course of her academic career, she has taught more than fifteen different courses and has supervised different final-year projects at undergraduate and master's levels. Prior to her academic appointment, she accumulated over six years of professional experience as a computer engineer, specializing in software development and systems administration.

She earned her Ph.D. in Computer Science in 2017 from the Universidad Complutense de Madrid. She is a member of the Grupo de Evolución Artificial (GEA), and her research activities focus on several areas, including hardware reconfiguration, energy efficiency, the study of neurological diseases, and precision agriculture.

Her research work prominently involves the application of Artificial Intelligence techniques, particularly evolutionary computation methods. She has served as Principal Investigator on two competitive national research projects, primarily focused on the application of AI to real-world problems, especially in the fields of energy efficiency and precision agriculture. Additionally, she has participated as a researcher in more than five research projects and eight knowledge transfer contracts, serving as coordinator in two of the latter.

She has authored more than 40 scientific publications, including 18 articles in impact-factor journals: 9 in Q1 journals, 6 in Q2 journals, and 3 in Q3/Q4 journals, as well as other indexed publications (h-index: 15). Her scholarly output also includes two book chapters and more than 15 papers published in the proceedings of national and international conferences, including GECCO, PPSN, and EvoStar, in addition to other preprint publications.

Some relevant scientific publications

- Álvarez, J.D., et al. An application of machine learning with feature selection to improve diagnosis and classification of neurodegenerative disorders. *BMC Bioinformatics* (2019). <https://doi.org/10.1186/s12859-019-3027-7>
- Josefa Díaz Álvarez, et al. Multi-objective optimization of energy consumption and execution time in a single level cache memory for embedded systems, *Journal of Systems and Software* (2016), <https://doi.org/10.1016/j.jss.2015.10.012>.
- Díaz-Álvarez, Josefa, et al. Population size influence on the energy consumption of genetic programming. *Measurement and Control*, 2022, vol. 55, p. 102-115. <https://doi.org/10.1177/00202940211064471>
- Cruz-Carrasco, C.; Díaz-Álvarez, J., et al. Detection of *Aspergillus flavus* in Figs by Means of Hyperspectral Images and Deep Learning Algorithms. *AgriEngineering* 2024, 6. <https://doi.org/10.3390/agriengineering6040225>
- Miragaia R, Chávez F, Díaz J, et al. Plum Ripeness Analysis in Real Environments Using Deep Learning with Convolutional Neural Networks. *Agronomy*. 2021; 11(11):2353. <https://doi.org/10.3390/agronomy11112353>
- Jordi A. Matias-Guiu, Josefa Díaz-Álvarez, et al. Machine learning in the clinical and language characterisation of primary progressive aphasia variants, *Cortex* (2019), <https://doi.org/10.1016/j.cortex.2019.05.007>.

Research projects as IP

- Synthesis and Exploration of Efficient Complex Systems applied to sustainable agronomy and creativity in music and design (SEECs::UEx). 01/09/2024 - 31/08/2027
- DemocraTAI::UEx Transparent Artificial Intelligence and applications: computer creativity and agro-food. 01/09/2021 - 31/08/2024

Contracts, technological or transfer merits

- Necesidades hídricas de higuera para producción de higo seco. Efectos de estrategias de riego deficitario y ajuste de programaciones de riego mediante inteligencia artificial. UEx-CICYTEX. 6 meses (09/05/2023-09/11/2023). IP
- CONVENIO DE COLABORACIÓN ENTRE LA UNIVERSIDAD DE EXTREMADURA Y LA S.M.E. INSTITUTO NACIONAL DE CIBERSEGURIDAD DE ESPAÑA M.P., S.A. PARA LA PROMOCIÓN DE CÁTEDRAS DE CIBERSEGURIDAD EN ESPAÑA: CÁTEDRA INCIBE-UEx-CUMe. Researcher.



ARTIFICIAL EVOLUTION GROUP (GEA)

University of Extremadura – Spain

<https://grupogea.unex.es/>

The Artificial Evolution Group (GEA) is a multidisciplinary research group mainly affiliated with the University of Extremadura (Spain). The group led by Dr Francisco Fernández de Vega specializes in the application of evolutionary computation techniques and bio-inspired algorithms to solve complex problems.

GEA develops and applies Parallel and Distributed Computational Intelligence, with particular emphasis on Computational Creativity, one of the most innovative and emerging branches of Artificial Intelligence, Agriculture, and the study of energy efficiency in AI algorithms, including Evolutionary Algorithms.

RESEARCH LINES

- Bio-inspired Algorithms
- New Production Processes in Design
- Parallel and Distributed Systems
- Parallel Modelling and Simulation of Complex Systems
- Software Tools for People with Disabilities
- Artificial Intelligence

APPLICATION AREAS

- Agriculture
- Healthcare
- Artistic Design
- Music
- Energy Efficiency
- Video Game Technologies applied to other domains

Notable research includes the application of Artificial Intelligence to improve the diagnosis of neurodegenerative diseases such as Primary Progressive Aphasia, and the use of video game technologies in new interdisciplinary contexts.

KEY INDICATORS

- Researchers: Dr. Francisco Fernández de Vega, Dra. Josefa Díaz Álvarez and Dr. Francisco Chávez de la O
- Approximately 275 Scientific Publications
- 4 Industrial Properties
- 27 Research Projects
- 11 PhD Theses Supervised
- More than 20 Years of Research Activity

NATIONAL AND INTERNATIONAL COLLABORATIONS

Over more than two decades, GEA has collaborated in research projects, conference organization, and joint publications with the following institutions:

- Michigan State University (USA)
- University of California (San Diego and Berkeley, USA)
- CERN (Switzerland)
- University of Lausanne (Switzerland)
- Centro de Investigación Científica y Educación Superior de Ensenada (Mexico)
- University of Applied Sciences Western Switzerland (HES-SO)
- University of Málaga
- University of Granada
- Complutense University of Madrid
- Autonomous University of Madrid
- University of the Basque Country
- European Association for Artificial Intelligence
- ACM GECCO
- IEEE CEC
- SIEGEVO EVOSTAR (Evostar 2020 – Seville)
- MAEB (2002 Inaugural Congress and X MAEB 2015 – Mérida)
- SEIB (2003 Congress – Mérida)
- CICYTEX – Scientific and Technological Research Center of Extremadura
- Collaboration with regional companies and research centers within SECTI
- Polytechnic University of Valencia
- University of Seville

RESEARCH PROPOSAL 1

Recently, members of the GEA research group have collaborated with researchers in Mexico to explore the automatic classification of Mexican wood varieties [1]. The present project seeks to extend this line of research by combining evolutionary computation and deep learning techniques.

Automatic wood classification using Artificial Intelligence represents a strategic tool for sustainable forest management, international traceability, and industrial quality control. Deep Neural Networks (DNNs) provide high accuracy in classification tasks; however, their optimization entails substantial computational costs. The integration of Genetic Algorithms (GAs) with DNNs enables efficient exploration of complex hyperparameter spaces, while the use of High-Performance Computing (HPC) infrastructures facilitates parallelization and scalability.

This project aims to adapt, optimize, and parallelize the baseline methodology for classifying wood species from Mexico, Spain, Europe, and other regions, leveraging HPC resources and assessing the environmental impact (CO₂ footprint) of the AI processes involved.

This research line is currently in progress, and we propose the following actions:

1. To analyze, adapt, and optimize the previous methodology described in [1] and its reference dataset, establishing collaborations with industry stakeholders to expand the dataset. In addition to Mexican wood species, Spanish and other European varieties will be incorporated. Visual, anatomical, and structural characteristics of wood cross-sections will be considered.
2. To design an evolutionary approach for optimizing the topology and architectural configuration of deep learning models, thereby generating a hybrid GA-DNN framework for supervised classification.
3. To adapt the system to HPC environments using parallelization techniques (e.g., MPI, Dask, and/or CUDA-GPU), enabling parallel evaluation of individuals and significant reductions in computational time. Additionally, the research methodology will incorporate the quantification and assessment of the environmental impact and energy efficiency associated with the optimization processes, taking into account the hardware resources employed.

For interested readers, more research works directly related to the proposal presented are available at <https://grupogea.unex.es/mjdiaz/mjdiaz.html>

According to the profile of the student, during the stay, some of previous ideas will be explored and developed.

1. Garduza-Ventura, J.P., Villegas-Cortez, J., Zúñiga-López, A., Mora-Gutiérrez, R.A., Díaz-Álvarez, J., O, F.C.d.l. (2025). Characterization and Classification of Mexican Woods Through Local Texture Analysis Using Deep Learning Techniques. Artificial Intelligence- COMIA 2025. Communications in Computer and Information Science, vol 2553. Springer, Cham. https://doi.org/10.1007/978-3-031-97910-1_26

RESEARCH PROPOSAL 2

Members of the GEA research group have recently established active collaboration with researchers in computational physics, materials science, computer science, and mathematics at the Universidad Autónoma Metropolitana, Unidad Azcapotzalco (Mexico). This partnership has opened a new interdisciplinary research line focused on cellular automata and correlated lattice systems.

The controlled generation and analysis of correlated lattice structures is a fundamental problem in computational physics and materials science. In particular, the ability to model disordered and nanoporous surfaces with prescribed spatial correlations is essential for understanding how geometry influences diffusion kinetics and transport properties in pharmaceutical, chemical, and agri-food materials. Developing advanced computational methodologies for constructing such structures, therefore represents both a theoretical and applied scientific challenge.

The main objective of this project is to advance the development of a computational platform based on evolutionary algorithms for optimizing the construction of triangular and honeycomb-type lattices with tunable spatial correlations. This will enable their application to surface modelling and texture characterization.

The research is at the first stages, and it will focus on three integrated methodological axes:

- Investigate state-of-the-art evolutionary computation, spatial correlation modelling, and lattice optimization techniques. Based on this analysis, design an evolutionary computing framework with tailored encoding strategies and fitness functions to quantify target correlation properties, ensuring the generation of lattice geometries that satisfy structural constraints with efficiency and robustness.
- Advance in the development of a modular and extensible system for generating correlated triangular and honeycomb lattices, including quantitative metrics for validation and benchmarking. Adapt the framework to model nanoporous ceramic and polymeric surfaces, enabling the generation of synthetic correlated topographies for analyzing emergent geometric and diffusion-related properties.
- Address the integration of the generated lattice structures with hyperspectral analysis methods applied to agricultural and chemically relevant materials of European–Mexican interest. Explore correlations between geometric texture descriptors and spectral signatures to improve surface characterization, product quality assessment, and traceability, establishing standardized and reproducible computational protocols.

This research aims to consolidate a long-term Mexico–Spain collaboration in applied computational science, strengthening interdisciplinary expertise in evolutionary modelling and materials characterization.

For interested readers, more research works directly related to the proposal presented are available at:

1. Jiménez Jiménez, Saul, Salomón Cordero-Sánchez, Rafael Villalobos García, J. Gerardo Mejía Hernández, y Juan Villegas-Cortez. 2025. “The Effect of bcc lattices on the Drug Release Kinetics in Inert Systems by Monte Carlo Simulation”. *Journal of the Mexican Chemical Society* 69 (1): 24–38. <https://doi.org/10.29356/jmcs.v69i1.2295>.