

Gabriela Ochoa

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Professor in Computing Science

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EDUCATION

PhD Computer Science and Artificial Intelligence , <i>University of Sussex, UK</i>	1997 – 2001
MRes Computer Science , (Distinction) <i>University Simon Bolivar, Venezuela</i>	1994 – 1996
BSc (Hons) Computer Science , (First) <i>University Simon Bolivar, Venezuela</i>	1985 – 1990

EMPLOYMENT HISTORY

Professor <i>Computing Science and Mathematics, University of Stirling</i>	2018 – Present <i>Stirling, UK</i>
Senior Lecturer <i>Division of Computing Science and Mathematics, University of Stirling</i>	2015 – 2018 <i>Stirling, UK</i>
Lecturer <i>Division of Computing Science and Mathematics, University of Stirling</i>	2012 – 2015 <i>Stirling, UK</i>
Senior Research Fellow / Research Fellow <i>Department of Computer Science, University of Nottingham</i>	2006 – 2012 <i>Nottingham, UK</i>
Associate / Assistant Professor <i>Department of Computer Science, University Simon Bolivar</i>	2001 – 2006 <i>Caracas, Venezuela</i>
Software Engineer <i>Several Companies</i>	1990 – 1995 <i>Caracas, Venezuela</i>

SUPERVISION

• PhD First supervisor: 1 (ongoing), 3 (completed)	2014 – 2023
• PhD Second Supervisor: 2 (completed)	2014 – 2023
• PhD Visiting: 6 (completed)	2014 – 2023
• Postdocs: 6 (completed)	2014 – 2019

SUMMARY OF PUBLICATIONS

175 published research articles, including 47 journal papers, 99 refereed conference papers (7 best-paper awards and 10 other nominations), 11 workshop papers, 7 book chapters and 6 edited volumes.
Google Scholar (April 2023): 9,200+ citations, H-index: 44

AWARDS / RECOGNITION

EvoStar Award <i>Outstanding contribution to Evolutionary Computation in Europe</i>	2020
Best Paper Awards: 7 awards EvoCOP (3), GECCO (2), EvoApps (1), PPSN (1) and 10 other nominations GECCO (6), EvoApps (2), EvoCOP (1), EuroGP (1)	2006 – 2023
Invited Talks: 11 keynote talks	2017 – 2024

PROFESSIONAL MEMBERSHIPS

SIGEVO Executive Board <i>The ACM Special Interest Group for Genetic and Evolutionary Computation</i>	2016 - Ongoing
ACM TELO Associate Editor <i>ACM Transactions on Evolutionary Learning and Optimization</i>	2018 - Ongoing
ECJ Editorial Board <i>Evolutionary Computation Journal, MIT Press</i>	2018 - Ongoing
SPECIES Society Executive Board <i>Leading European Society on Bio-Inspired Computation</i>	2017 - Ongoing
ECJ Associated Editor <i>Evolutionary Computation Journal, MIT Press</i>	2012 - 2018

SPECIES Scholarship: Host Submission

Gabriela Ochoa, University of Stirling,
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1 University of Stirling

The University of Stirling is a leading UK research-intensive university. In the most recent Research Excellence Framework (REF), the UK's system to assess research, 7% of our research has an outstanding or very considerable impact on society and more than 80% is world-leading or internationally excellent. About the city of Stirling: Also known as the "Gateway to the Highlands", Stirling is the perfect place to study. It combines the charm of a historic city with the buzz of a young community. 20% of Stirling's 100,000 people are between 16 and 29 years old (National Records of Scotland 2016). And two of Scotland's main cities - Edinburgh and Glasgow - are around 40 minutes away, perfect for fun weekend adventures.

2 Research Projects

Optimisation is a crosscutting, ubiquitous activity in science, industry and commerce. Optimisation problems arise in a broad range of real-world situations where resources are constrained and one or multiple criteria need to be satisfied. In the last few decades, a large number of metaheuristics have been proposed, inspired by various natural phenomena. Combined with the increased number of algorithms is a knowledge gap in understanding the dynamics of evolutionary algorithms and other metaheuristics, and how to effectively select and configure them. These research projects aim to fill this gap, by developing visualisation and analysis tools that facilitate an informed choice of optimisation methods through a deeper understanding of the fitness landscape and algorithms' dynamics.

2.1 Background and Definitions

Local optima **Local optima networks (LONs)** [8] are a graph-based model of fitness landscapes suited to characterising their global structure. LONs convey a compressed view of a landscape as a network (or graph) where nodes are local optima, according to a given neighbourhood, and edges

are possible transitions among optima according to an escape operator. LONs have been applied to several classic discrete and continuous optimisation problems, and more recently to hyper-parameter spaces [1, 14] and neural architecture search [9, 10]. LONs for multi-objective optimisation problems have also been recently proposed [4, 5], but they have not been yet widely explored.

Search trajectory networks (STNs) [7] are a graph-based tool to visualise and analyse the dynamics of any type of metaheuristic: evolutionary, swarm-based or single-point, on both continuous and discrete search spaces. STNs were originally proposed for single-objective optimisation and only recently extended to multi-objective optimisation [3, 6]. STNs have been applied to classical benchmark optimisation problems as well as to neuroevolution [12, 11] and genetic programming [2]. There is still room for improving and applying this tool to new scenarios.

3 Proposed Projects

1. **LONs for Multi-objective Problems.** So far, LONs have been applied to small multi-objective synthetic benchmark problems in combinatorial optimisation. This project will aim to construct and analyse LONs for larger problems in either continuous or discrete search spaces. We will consider existing benchmarks including real-world problems. We will explore visualisation methods and assess the usefulness of the LON features in performance prediction.
2. **Understanding Complex Search Spaces.** This project will look at extending the application of LON or STNs to neuroevolution, neural architecture search (NAS), genetic programming, or hyper-parameter search spaces, in order to improve our understanding of landscapes and effective algorithms in these complex domains. Apart from the genotypes, we will consider the phenotype and behavioural spaces as ways of representing more concise models.
3. **Open Topics in LONs or STNs.** This is an open project in which I will welcome the creativity and enthusiasm of students willing to improve any aspect of LONs or STNs, or apply these tools to any new domain, including combinatorial or continuous search spaces. One possibility is to extend the use of LLMs to interpret LON or STN models [13].

References

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- lutionary Computation Conference, Companion*, pages 1657–1664. ACM, 2021.
- [2] Ting Hu, Gabriela Ochoa, and Wolfgang Banzhaf. Phenotype search trajectory networks for linear genetic programming. In Gisele L. Pappa, Mario Giacobini, and Zdenek Vasíček, editors, *Genetic Programming - 26th European Conference, EuroGP 2023*, volume 13986 of *Lecture Notes in Computer Science*, pages 52–67. Springer, 2023.
 - [3] Yuri Cossich Lavinias, Claus Aranha, and Gabriela Ochoa. Search trajectories networks of multiobjective evolutionary algorithms. In Juan Luis Jiménez Laredo, José Ignacio Hidalgo, and Kehinde O. Babaagba, editors, *Applications of Evolutionary Computation - EvoApplications 2022*, volume 13224 of *Lecture Notes in Computer Science*, pages 223–238. Springer, 2022.
 - [4] Arnaud Liefooghe, Bilel Derbel, Sébastien Verel, Manuel López-Ibáñez, Hernán Aguirre, and Kiyoshi Tanaka. On pareto local optimal solutions networks. In *Parallel Problem Solving from Nature (PPSN XV)*, pages 232–244, Coimbra, Portugal, 2018. Springer.
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 - [8] Gabriela Ochoa, Marco Tomassini, Sébastien Verel, and Christian Darabos. A study of nk landscapes’ basins and local optima networks. In *Genetic and Evolutionary Computation Conference (GECCO 2008)*, pages 555–562, Atlanta, GA, USA, 2008. ACM.
 - [9] Gabriela Ochoa and Nadarajen Veerapen. Neural architecture search: A visual analysis. In *Parallel Problem Solving from Nature - PPSN XVII*, volume 13398 of *Lecture Notes in Computer Science*, pages 603–615. Springer, 2022.

- [10] Nuno M. Rodrigues, Katherine M. Malan, Gabriela Ochoa, Leonardo Van-neschi, and Sara Silva. Fitness landscape analysis of convolutional neural network architectures for image classification. *Inf. Sci.*, 609:711–726, 2022.
- [11] Stefano Sarti, Nuno Lourenço, Jason Adair, Penousal Machado, and Gabriela Ochoa. Under the hood of transfer learning for deep neuroevolution. In João Correia, Stephen L. Smith, and Raneem Qaddoura, editors, *Applications of Evolutionary Computation - EvoApplications 2023*, volume 13989 of *Lecture Notes in Computer Science*, pages 640–655. Springer, 2023.
- [12] Stefano Sarti and Gabriela Ochoa. A neat visualisation of neuroevolution trajectories. In Pedro A. Castillo and Juan Luis Jiménez Laredo, editors, *Applications of Evolutionary Computation*, pages 714–728, Cham, 2021. Springer International Publishing.
- [13] Camilo Chacón Sartori, Christian Blum, and Gabriela Ochoa. Large language models for the automated analysis of optimization algorithms. *arXiv preprint arXiv:2402.08472*, 2402.08472, 2024.
- [14] German Treimun-Costa, Elizabeth Montero, Gabriela Ochoa, and Nicolás Rojas-Morales. Modelling parameter configuration spaces with local optima networks. In Carlos Artemio Coello Coello, editor, *Genetic and Evolutionary Computation Conference, GECCO 2020*, pages 751–759. ACM, 2020.