University of Stirling, Scotland
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Gabriela Ochoa

Professor in Computing Science

GitHub: gabro8a
University Profile
Google Scholar

Education

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

Employment History

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

Summary of Publictions

154 published research articles, including 45 journal papers, 90 refereed conference papers (5 best-paper awards and 9 other nominations), 9 workshop papers, 5 book chapters and 4 edited volumes.
Google Scholar (April 2023): 7,300+ citations, H-index: 42

Awards / Recognition

EvoStar Award *Outstanding contribution to Evolutionary Computation in Europe* 2020

Best Paper Awards: 6 awards EvoCOP (3), EvoApps (1), GECCO (1), PPSN (1) and 9 other nominations GECCO (5), EvoApps (2), EvoCOP (1), EuroGP (1) 2006 – 2023

Invited Talks: 10 keynote talks 2017 – 2022

Professional Memberships

SIGEVO Executive Board 2016 - Ongoing
The ACM Special Interest Group for Genetic and Evolutionary Computation

ACM TELO Associate Editor 2018 - Ongoing
ACM Transactions on Evolutionary Learning and Optimization

ECJ Editorial Board 2018 - Ongoing
Evolutionary Computation Journal, MIT Press

SPECIES Society Executive Board 2017 - 2023
Leading European Society on Bio-Inspired Computation

ECJ Associated Editor 2012 - 2018
Evolutionary Computation Journal, MIT Press

SPECIES Scholarship: Host Submission

Gabriela Ochoa, University of Stirling, Scotland, UK

April 24, 2023

University of Stirling

Stirling is a leading UK research-intensive university (https://www.stir.ac.uk/). In the most recent Research Excellence Framework (REF), the UK's system for assessing the excellence of research, 7% of the University's research has an outstanding or very considerable impact on society. More than 80% of Stirling's research is world-leading or internationally excellent.

About the city of Stirling (https://www.stir.ac.uk/student-life/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 50 minutes away, perfect for fun weekend adventures."

Data Science and Intelligent Systems (DAIS) Research Group

The DAIS research group consists of 15 academics, 2 postdocs and 14 PhD students, its mission is to conduct interdisciplinary research to explore, develop, and apply search and optimisation methodologies, evolutionary computation, machine learning, and signal processing to a wide range of real-world, data-driven problems. Current innovative projects involve the analysis and visualisation of fitness landscapes (www.lonmaps.com), and computational vision and image processing (http://vip.cs.stir.ac.uk).

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.

Background and Definitions

Local optima networks (LONs) [7] are a 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 a number of discrete and continuous optimisation problems, and more recently neural architecture search [8, 9]. LONs for multi-objective optimsation problems have also been recently proposed [3], but they have not been widely explored.

Search trajectory networks (STNs) [5, 6] 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 [5, 6] and only recently extended to to multi-objective optimisation [2, 4]. STNs have been applied to classical benchmark optimisation problems as well as to neuroevolution [11, 10] and genetic programming [1]. There is still room for improving and applying this tool to new scenarios.

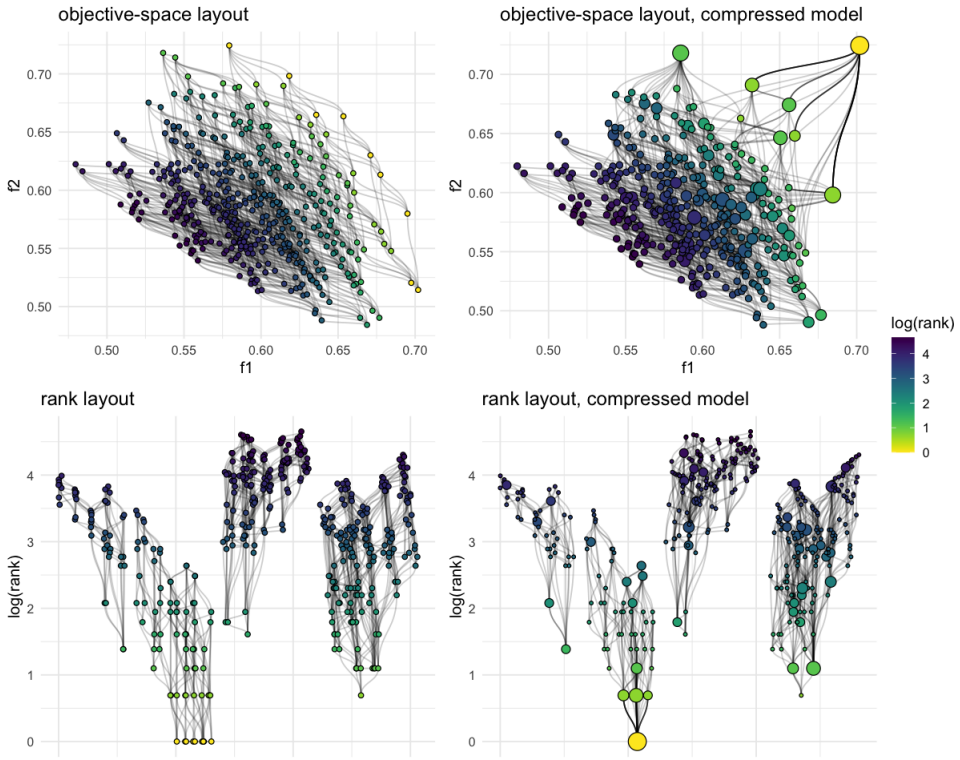

Figure 1: Different models and visualisation layouts for LONs in a small multi-objective discrete problem.

Proposed Projects

1. **LONs for Large Multi-objective Problems**. So far, LONs have been applied to small multi-objective benchmark problems in combinatorial optimisation. This project will aim to explore sampling techniques to construct LONs for larger problems in either continuous or discrete search spaces. We will explore ways of aggregating nodes and edges from sampling the landscape. We will consider existing benchmarks including real-world problems. Figure 1 shows a recent example visualisation for a small multi-objective combinatorial landscape. The idea is to extend this to more realistic settings.

2. **Understanding Neuroevolution and Neural Architecture Search**. This project will look at extending the application of LON or STNs to relevant neuroevolution or neural architecture search (NAS) systems, in order to improve our understanding of landscape and effective algorithms in these domains.

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 a new domain.

References

[1] Hu, T., Ochoa, G., and Banzhaf, W. Phenotype search trajectory networks for linear genetic programming. In *European Conference on Genetic Programming, EuroGP 2023* (2023), vol. 13986 of *Lecture Notes in Computer Science*, Springer, pp. 52–67.

[2] Lavinas, Y. C., Aranha, C., and Ochoa, G. Search trajectories networks of multiobjective evolutionary algorithms. In *Applications of Evolutionary Computation, EvoApplications* (2022), vol. 13224 of *Lecture Notes in Computer Science*, Springer, pp. 223–238.

[3] Liefooghe, A., Derbel, B., Verel, S., López-Ibáñez, M., Aguirre, H., and Tanaka, K. On pareto local optimal solutions networks. In *Parallel Problem Solving from Nature – PPSN XV* (Cham, 2018), Springer International Publishing, pp. 232–244.

[4] Ochoa, G., Liefooghe, A., Lavinas, Y. C., and Aranha, C. Decision/objective space trajectory networks for multi-objective combinatorial optimisation. In *Evolutionary Computation in Combinatorial Optimization, EvoCOP 2023* (2023), vol. 13987 of *Lecture Notes in Computer Science*, Springer, pp. 211–226.

[5] Ochoa, G., Malan, K. M., and Blum, C. Search trajectory networks of population-based algorithms in continuous spaces. In *Applications of Evolutionary Computation* (Cham, 2020), Springer International Publishing, pp. 70–85.

[6] Ochoa, G., Malan, K. M., and Blum, C. Search trajectory networks: A tool for analysing and visualising the behaviour of metaheuristics. *Applied Soft Computing 109* (2021), 107492.

[7] Ochoa, G., Tomassini, M., Verel, S., and Darabos, C. A study of NK landscapes' basins and local optima networks. In *Proceedings of the 10th Annual Conference on Genetic and Evolutionary Computation* (New York, NY, USA, 2008), GECCO '08, ACM, pp. 555–562.

[8] Ochoa, G., and Veerapen, N. Neural architecture search: A visual analysis. In *Parallel Problem Solving from Nature - PPSN XVII - 17th International Conference, PPSN 2022, Dortmund, Germany, September 10-14, 2022, Proceedings, Part I* (2022), vol. 13398 of *Lecture Notes in Computer Science*, Springer, pp. 603–615.

[9] Rodrigues, N. M., Malan, K. M., Ochoa, G., Vanneschi, L., and Silva, S. Fitness landscape analysis of convolutional neural network architectures for image classification. *Inf. Sci. 609* (2022), 711–726.

[10] Sarti, S., Laurenço, N., Adair, J., Machado, P., and Ochoa, G. Under the hood of transfer learning for deep neuroevolution. In *Applications of Evolutionary Computation* (Cham, 2023), Springer Nature Switzerland, pp. 640–655.

[11] Sarti, S., and Ochoa, G. A NEAT visualisation of neuroevolution trajectories. In *Applications of Evolutionary Computation - EvoApps 2021* (2021), vol. 12694 of *Lecture Notes in Computer Science*, Springer, pp. 714–728.