Manuel López-Ibáñez – CV
manuel.lopez-ibanez@uma.es
http://lopez-ibanez.eu

"Beatriz Galindo" Senior Distinguished Researcher 2020 – Present
Department of Programming Languages and Computer Science, School of Computer Science, University of Málaga. Bulevar Louis Pasteur, 35, Campus de Teatinos. 29071 Málaga, Spain.

Senior Lecturer (Associate Professor) 2018 – Present
at Alliance Manchester Business School, University of Manchester, UK.

Academic Qualifications
PhD from Edinburgh Napier University, United Kingdom, 2009
Ingeniero en Informática (Spanish equivalent of MS degree in Computer Science), University of Granada, Spain, 2004

Research Interests
I am interested in improving the understanding of **optimization algorithms** by empirical means, and I am particularly interested in **multi-objective multidisciplinary problems** arising from logistics, manufacturing, bioinformatics, etc. These interests include **evolutionary algorithms**, **matheuristics**, **metaheuristics** and **stochastic local search methods**, their **automatic selection, configuration (hyper-parameter optimization)** and design, and **expensive black-box optimization**, including **Bayesian optimization.**

Publication Track-Record and Citations
28 journal papers (24 in journals indexed ISI-JCR, 20 in Q1), 9 book chapters and 51 papers in peer-reviewed proceedings of international conferences, and edited 6 books.
According to the Google Scholar database (or SCOPUS and excluding self-citations):
- H-index: 32 (SCOPUS : 23)
- Total number of citations: More than 4772 (SCOPUS : 2584)

Selection of Software Published **(complete list:** http://lopez-ibanez.eu/research **)**
- **irace R package:** Automatic configuration (offline tuning) of optimization algorithms. More than 108,000 downloads (April, 2021) https://mlopez-ibanez.github.io/irace/
- **eaf R package:** Performance assessment of multi-objective optimizers. More than 78,000 downloads (April 2021) https://mlopez-ibanez.github.io/eaf/

Recent Publications **(complete list:** http://lopez-ibanez.eu/publications)
1. Juan Esteban Diaz and Manuel López-Ibáñez. **Incorporating Decision-Maker's Preferences into the Automatic Configuration of Bi-Objective Optimisation Algorithms**. *European Journal of Operational Research*, 289(3):1209–1222, 2021. Editor's Choice Award.
2. Leonardo C. T. Bezerra, Manuel López-Ibáñez, and Thomas Stützle. **Automatically Designing State-of-the-Art Multi- and Many-Objective Evolutionary Algorithms**. *Evolutionary Computation*, 28(2):195–226, 2020.
3. Javier Ferrer, Manuel López-Ibáñez, and Enrique Alba. **Reliable Simulation-Optimization of Traffic Lights in a Real-World City**. *Applied Soft Computing*, 78:697–711, 2019.
4. Manuel López-Ibáñez, Jérémie Dubois-Lacoste, Leslie Pérez Cáceres, Thomas Stützle, and Mauro Birattari. The ir**ace Package: Iterated Racing for Automatic Algorithm Configuration.** *Operations Research Perspectives*, 3:43–58, 2016.
(*1033 citations according to Google Scholar)*
5. Leonardo C. T. Bezerra, Manuel López-Ibáñez, and Thomas Stützle. **Automatic Component-Wise Design of Multi-Objective Evolutionary Algorithms.** *IEEE Transactions on Evolutionary Computation*, 20(3):403–417, 2016.

Mentoring Experience
Currently supervising 5 PhD students (2 as main supervisor), 5 other PhD students successfully completed their PhD. I have also supervised more than 20 MSc dissertations.

Description of the Research Group

Dr Manuel López-Ibáñez is affiliated with the NEO Research Group (https://neo.lcc.uma.es), which is part of the Institute of Software Engineering and Technology (https://itis.uma.es) and the Department of Languages and Computer Science of the University of Malaga (Spain).

NEO is composed of both young and experienced members working on applying artificial intelligence and software engineering to solve multidisciplinary real-world problems. The head of the group is Prof Enrique Alba and other permanent members include Dr Francisco Chicano and Dr Gabriel Luque.

The selected candidate student will integrate fully with the NEO group, participating in seminars, scientific meetings, social activities, etc. We will provide an office space and computational resources. The group participates in several international collaborations and projects, including the TAILOR network (Trustworthy AI - Integrating Learning, Optimisation and Reasoning, https://tailor-network.eu/).

Málaga is a vibrant and welcoming city in the south of Spain. Due to its international airport and the beauty of its coast, it receives international tourists for most of the year, making it easy to navigate for international students even without knowing Spanish. There is an active and outgoing expat community from many countries, including UK, France and Germany. Finding temporary accommodation for one or two people is relatively easy due to large affluence of tourists and the large student population. If desired, there is the possibility of arranging single-room accommodation in student residences if requested well in advance. Living costs in Málaga are lower than in other parts of Spain, including Madrid, Valencia and Barcelona, and significantly lower than in most West European cities.

Project #1: Automatic Design of Multi-objective Algorithms for the Optimisation of Supply Chains

The optimal design of supply chains (for example, for healthcare applications) are complex mixed-integer optimisation problems that typically combine location-allocation problems (for deciding where to locate various facilities), multi-mode resource-constrained project scheduling [1] (for deciding on the sequence of steps of some process taking into account resource constraints and modes of production) and vehicle routing (for deciding the best way to transport the different products across the network of suppliers), under uncertainty due to fluctuations in demand and costs, and potential failures of some nodes of the network. Moreover, some (black-box) constraints may require the use of simulation before being evaluated [2], which further complicates the resolution of the problem.

Recent work has shown that combining automatic configurations tools with flexible component-wise algorithmic frameworks can produce new algorithmic designs that outperform those proposed in the literature [3,4]. This project is about applying this idea to the design of high-performance metaheuristics for tackling the optimisation of supply chains.

This project offers the candidate an opportunity to learn about advanced uses of modern automatic configuration tools such as irace [5] and their application to the configuration and design of multi-objective optimisation algorithms. The student will also learn about the design of metaheuristics from a component-wise perspective and how the principles of evolutionary computation can be found in other metaheuristics, such as stochastic local search and large neighbourhood search, and vice versa. This component-wise perspective gives rise to a huge design space of hybrid metaheuristics that may be tailored to specific scenarios, such as the design of supply chain networks.

The tasks of the student would be (with help from the host supervisor):

1. Research algorithmic components (crossover and mutation operators, neighborhoods, perturbation steps, tabu lists, constraint handling methods, etc) that are applicable to the chosen problem.
2. Implement these components as a hybrid metaheuristic with several parameters.
3. Apply irace to identify the most appropriate design of this hybrid metaheuristic.
4. Using the information collected by irace, analyse which problem features influence the design of the hybrid metaheuristic towards better understanding those choices.

Pre-requisites:

- Knowledge about EAs and metaheuristics applied to mixed-integer problems with constraints.
- Basic programming skills in C++, Python, R, Java, etc.
- NO knowledge about irace or automatic configuration required (it is part of the training offered)

References:

1. M. López-Ibáñez, F. Mascia, M.-E. Marmion, and T. Stützle. **Automatic Design of a Hybrid Iterated Local Search for the Multi-Mode Resource-Constrained Multi-Project Scheduling Problem**. In G. Kendall, et al., editors, *Multidisciplinary International Conference on Scheduling: Theory and Applications (MISTA 2013)*, pages 1–6, Belgium, 2013.
2. F. Massen, M.López-Ibáñez, T. Stützle, and Y.Deville. **Experimental Analysis of Pheromone-Based Heuristic Column Generation Using irace**. In M. J. Blesa, et al., *Hybrid Metaheuristics*, volume 7919 of *LNCS*, pages 92–106. Springer, Heidelberg, Germany, 2013.
3. M.López-Ibáñez and T. Stützle. **The Automatic Design of Multi-Objective Ant Colony Optimization Algorithms**. *IEEE Transactions on Evolutionary Computation*, 16(6):861–875, 2012.
4. L.C. T. Bezerra, M.López-Ibáñez, and T.Stützle. **Automatically Designing State-of-the-Art Multi- and Many-Objective Evolutionary Algorithms**. *Evolutionary Computation*, 28(2):195–226, 2020.
5. M.López-Ibáñez, J.Dubois-Lacoste, L.Pérez Cáceres, T.Stützle, M.Birattari. **The irace Package: Iterated Racing for Automatic Algorithm Configuration**. *Operations Research Perspectives*, 3:43–58, 2016.

Project #2: Parameter Importance and Sensitivity in Automatic Algorithm Configuration

In offline automatic algorithm configuration, the goal is to find a good parameter configuration of algorithm before solving unseen instances of a problem by training on similar problem instances. The decision space of such algorithm configuration scenarios is a list of algorithm parameters together with their types (integer, real, categorical, ordinal, etc), domains, and constraints. However, in many cases, users can provide more insights into the parameter space, such as information about dependencies among parameters and their relative importance and sensitivity [2,3].

This project offers the candidate an opportunity to learn about the state of the art in automatic configuration tools such as irace [1] and work on creating the next generation of automatic configuration methods. The candidate will learn about the intricacies of algorithm configuration spaces and real-world cases of scenarios with known dependencies, importances and sensitivities.

The tasks of the student would be (with help from the host supervisor):

1. Identify and classify the types of information that an algorithm designer could provide regarding parameter dependencies, importances and sensitivities.
2. Implement methods to make use of this additional information in an automatic configuration tool such as irace.
3. Compare and analyse the benefits of the various methods.

Pre-requisites:

- Knowledge about automatic configuration methods, in particular irace.
- Excellent programming skills in Python or R.

References:

1. M.López-Ibáñez, J.Dubois-Lacoste, L.Pérez Cáceres, T.Stützle, M.Birattari. **The irace Package: Iterated Racing for Automatic Algorithm Configuration**. *Operations Research Perspectives*, 3:43–58, 2016.
2. Philipp Probst, Bernd Bischl, and Anne-Laure Boulesteix. **Tunability: Importance of Hyperparameters of Machine Learning Algorithms**. *Arxiv preprint arXiv:1802.09596*, 2018.
3. Paola Pellegrini, Franco Mascia, Thomas Stützle, and Mauro Birattari. **On the Sensitivity of Reactive Tabu Search to its Meta-parameters**. *Soft Computing*, 18(11):2177–2190, 2014.

Project #3: Visualizations of the Empirical Attainment Function with ggplot2, plotly and plot3Dgl

The empirical attainment function (EAF) [1] describes the probabilistic distribution of the outcomes obtained by a stochastic algorithm in the objective space. The eaf R package [2] may be used to visualize the EAF and the differences between EAFs. These plots may be used to explore the performance of stochastic local search algorithms for biobjective optimization problems and help in identifying certain algorithmic behaviours in a graphical way. These plots are widely used in research and data analysis. The eaf package has been downloaded more than 79,000 times since its release.

Ggplot2 [3] is an advanced plotting system for R, based on the grammar of graphics. Plots produced by ggplot2 can be converted in beautiful interactive web visualisations thanks to Plotly (https://plotly.com/r/). In addition, Plotly offers interactive 3D visualizations. There are other R packages that also provide the tools for building advanced 3D visualizations such as plot3Drgl (https://CRAN.R-project.org/package=plot3Drgl).

The goal of this project is to make the visualizations in the eaf R package interactive by converting them to ggplot2 and plotly. If time permits, an additional goal would be to implement 3D visualizations of the EAF for algorithms with three objectives such as those proposed by Tusar and Filipic [4].

During this project, the candidate will learn about the attainment function for the analysis of stochastic multi-objective optimizers and its visualization. This project also provides an opportunity to learn to create beautiful interactive visualizations with ggplot2, plotly and plot3Drgl.

Pre-requisites

- Knowledge of the R language or a desire to learn it to an advanced level in short time.
- A love for beautiful visualisations, either in 2D or 3D.

Relevant literature

1. Viviane Grunert da Fonseca and Carlos M. Fonseca. **The Attainment-Function Approach to Stochastic Multiobjective Optimizer Assessment and Comparison**. In T. Bartz-Beielstein, M. Chiarandini, L. Paquete, and M. Preuss, editors, *Experimental Methods for the Analysis of Optimization Algorithms*, pages 103–130. Springer, Berlin, Germany, 2010.

2. Manuel López-Ibáñez, Luís Paquete, and Thomas Stützle. **Exploratory Analysis of Stochastic Local Search Algorithms in Biobjective Optimization**. In T. Bartz-Beielstein, M. Chiarandini, L. Paquete, and M. Preuss, editors, *Experimental Methods for the Analysis of Optimization Algorithms*, pages 209–222. Springer, Berlin, Germany, 2010. http://dx.doi.org/10.1007/978-3-642-02538-9_9

3. ggplot2: Elegant Graphics for Data Analysis by Hadley Wickham. https://ggplot2.tidyverse.org/

4. Tea Tušar and Bogdan Filipič. **Visualizing Exact and Approximated 3D Empirical Attainment Functions**. *Mathematical Problems in Engineering*, 2014, 2014. Article ID 569346