

Summarized CV of Francisco Chicano

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Scientific production

Francisco Chicano has 36 publications in journals indexed by JCR, 6 publications in other journals, 10 book chapters, 35 publications in conferences listed in the CORE ranking (1 in A*, 21 in CORE A, 11 in CORE B and 2 in CORE C), 25 publications in other international conferences and 27 publications in national ones. He has been awarded with 6 best paper awards in international conferences (GECCO 2008, ISDA 2011, EvoCOP 2012, twice in GECCO 2018 and EvoCOP 2019) and got 6 best paper nominations (GECCO 2007, GECCO 2011, GECCO 2012, GECCO 2015, GECCO 2017, EvoApps 2021). He has been proceedings editor in 10 conferences (4 national and 6 international). He has h-index 32 according to Google Scholar.

Research activities

The researcher is (or has been) involved in 8 national research projects, (one as co-PI), 1 European project, 1 regional project (Junta de Andalucía), 4 local projects (Universidad de Málaga), in two as PI, and 10 transference contracts with companies and institutions. In 2013 he received a "José Castillejo" 10.500€ grant to do a research stay in the Computer Science Department of Colorado State University and a Fulbright grant (only 5 in Spain in 2013).

Research management and organization

Francisco Chicano is in the **editorial board** of Journal of Systems and Software, Evolutionary Computation Journal, Mathematical Problems in Engineering, Engineering Applications of Artificial Intelligence, Electronics and is **Area Editor** in ACM Transactions on Evolutionary Learning and Optimization. He has been guest editor in IEEE Transactions on Evolutionary Computation (special issue on Theoretical Foundations of Evolutionary Computation), Algorithmica (special issue on selected papers of Theory @ GECCO 2015) and Journal of Heuristics (special issue on Metaheuristics for COP). He has been **editor-in-Chief** in GECCO 2021 and has been **Track Chair** in GECCO 2013, GECCO 2015, GECCO 2019 and GECCO 2020, **Program Chair** in EvoCOP 2015 and EvoCOP 2016. He has also been **Workshop Organizer of the QuantOpt Workshop** in GECCO 2022 (focused on Quantum Computing and Optimization), **Track Chair** in the SBSE Track of JISBD since 2015 to 2017, 2021 and 2022, General Session Chair of CAEPIA 20/21, Late-Breaking Abstract Chair in GECCO 2016, Proceedings Chair in GECCO 2017, Electronic Media Chair in GECCO 2018 and Publication Chair in Smart-CT 2016 and 2017.

Mentoring experience

Francisco Chicano is or has been co-advisor of 6 PhD students (3 of them completed), 5 master students (currently advising 4) and advised the undergraduate thesis of more than 40 students.

Description of the Research Group



The NEO Research Group (<https://neo.lcc.uma.es>) 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 researchers with **multidisciplinary research abilities** in the field of applied artificial intelligence and optimization. Application domains include Software Engineering, Smart Cities, Transport and Logistics, Telecommunications and Bioinformatics. The group also has experience **producing software prototypes and open-source code** (see our GitHub site at <https://github.com/NEO-Research-Group>). NEO has many international collaborators and is visited by international researchers (around 5 or 6 every year, except during COVID-19 pandemics).

The group is currently composed of 11 members (9 doctors and 2 PhD students). **Dr. Enrique Alba**, head of the group (now in Brussels, as seconded national expert of ERC), **Dr. Francisco Chicano** (quantum computing, search-based software engineering, combinatorial optimization), **Dr. Zakaria Dahi** (quantum computing and evolutionary computation); **Dr. Gabriel Luque** (metaheuristics, high-performance computing, dynamic problems, software development); **Dr. Javier Ferrer** (automatic test case generation using AI, logistics), **Dr. Manuel López-Ibáñez** (optimal parameterization of intelligent techniques, machine learning and reproducibility); **Dr. Rubén Saborido** (automatic refactoring to improve software quality and non-functional requirements); **Dr. Jamal Toutouh** (smart cities, machine learning and generative models); **Dr. Rodrigo Gil-Merino** (quantum computing, machine learning, gravitational lenses); **Mg. Christian Cintrano** (smart cities and software development); **Mg. José Ángel Morell** (ubiquitous computing and federated learning).

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, as well as access to all the facilities of the university (library access and computational resources). We can also provide a desktop computer if the student is not bringing his/her own laptop. We have a cluster of computers specially for the NEO group to run the experiments. The group participates in several international collaborations and projects, including the TAILOR network (Trustworthy AI - Integrating Learning, Optimisation and Reasoning, <https://tailor-network.eu/>).

Project #1: Embedding in Quantum Annealers

Quantum Computing is a new computing paradigm that promises to yield a revolution in Computer Science, due to the quantum physics features that exploits to do computations. Entanglement, and, specially, superposition are quantum effects that allow to speed up computations compared to the performance in a classical machine and open the door to computations that are not practical in a classical computer, like quantum mechanics simulations.

Two main kinds of quantum computers exist: quantum-gate computers and quantum annealers. Quantum annealers solve optimization problems formulated as Quadratic Unconstrained Binary Optimization (QUBO). While QUBO is a well-known and old problem, the recent interest in quantum computing encouraged researchers to better understand QUBO and provide methodologies to transform optimization problems into QUBOs. Formally, an instance of QUBO is a function $f(x) = x^T Qx + a$, where Q is a $n \times n$ real matrix and a is a real constant.

Quantum annealers are composed of qubits with some links between them. A quantum annealer is characterized by an architecture, which is a graph $G(V, E)$ where V is the set of qubits and E is the set of interconnections between those qubits. Typically, not all the qubits are linked between them. Some examples of architectures are D-Wave's chimera and pegasus. To solve a QUBO in a quantum annealer, we need to map each variable to a set of physical qubits and assign a weight to the edges between qubits. The mapping must be in such a way that variables with a nonzero interaction in the QUBO are mapped to sets of qubits that are adjacent in the quantum annealer architecture. This is finding a minor embedding of the graph representing the QUBO to the architecture. There can be many possible minor embeddings and not are equally good, according to the number of qubits used or the errors obtained after the computation.

The goal of this project is to apply evolutionary computation to find minor embeddings of graphs representing a QUBO problem into a quantum annealing architecture.

Tasks

1. Study the minor embedding problem and the embedding techniques used in practice in real quantum annealers
2. Propose a representation for the minor embedding problem and a metaheuristic algorithm to solve it
3. Run a set of experiments to check and improve the performance of the algorithm
4. Write the proposal and results in a paper to be submitted to Evostar 2024.

References

1. Kochenberger, Gary; Hao, Jin-Kao (2014). "The unconstrained binary quadratic programming problem: a survey" (PDF). *Journal of Combinatorial Optimization*. 28: 58–81. doi:10.1007/s10878-014-9734-0. S2CID 16808394.
2. D-Wave. QPU architecture. https://docs.dwavesys.com/docs/latest/c_gs_4.html

Project #2: Incomplete MaxSAT solver based on crossover

SAT and MaxSAT are classical decision and optimization problems in computer science that are at the core of many applications. Many efficient solvers exist for these two problems and new solvers appear every year in the annual MaxSAT evaluation competition (<https://maxsat-evaluations.github.io>).

Recent advances in gray-box optimization have shown that efficient crossover operators can be combined with iterated local search to find competitive results in MaxSAT. The goal of this project is to build an incomplete MaxSAT solver to compete in the MaxSAT evaluation competition. Code is available in Java with the main components of the crossover and local search already implemented.

Tasks

1. Study the state of the art in incomplete MaxSAT solvers and identify the best ones
2. Propose a new incomplete solver based on crossover and local search to solve MaxSAT
3. Run a set of experiments to check the performance of the proposed solver
4. Send the proposed solver to MaxSAT Evaluation 2023
5. Write the proposal and results in a paper to be submitted to Evostar 2024.

References

1. Wenxiang Chen, L. Darrell Whitley, Renato Tinós, Francisco Chicano: Tunneling between plateaus: improving on a state-of-the-art MAXSAT solver using partition crossover. GECCO 2018: 921-928
2. Francisco Chicano, Gabriela Ochoa, L. Darrell Whitley, Renato Tinós: Dynastic Potential Crossover Operator, Evolutionary Computation Journal, https://doi.org/10.1162/evco_a_00305

Other relevant information

About the city

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. 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.