ICFO



PhD THESIS DEFENSE: Optimization with spin glass models

DAVID CIRAUQUI GARCIA

September 27, 2024
10:30
Auditorium

With applicability on almost every aspect of our lives, optimization problems are ubiquitous to a broad range of fields within both scientific research and industrial environments. As such, these are growing in size and complexity at a fast pace, and are only expected to continue to do so. Accordingly, the urgency for better methods that can yield more optimal solutions in shorter times is increasing and, while the development of quantum computing technologies that are capable of tackling these problems evolves steadily, it does so too slowly for the challenges that nowadays society's demands represent. Consequently, a lot of effort is being invested to further develop classical methods and machines that are specially designed to solve optimization problems of relevant enough sizes. The present thesis is framed within this paradigm: classical optimization techniques are studied from various different perspectives, with the goal of improving their efficiency.

To this end, we first dive into basic concerns related to the physical properties of the systems that allow for the convenient formulation of industrially-relevant optimization problems, namely spin glasses with quenched disorders. The understanding of such properties is of utmost importance for the correct designing of the annealing schedules used by thermally-based optimization methods. We then study the impact that the hidden correlations of the pseudo random number streams used in their simulations have in the results by comparing simulations using PRNGs of various qualities and perfectly random QRNGs. To conclude, we investigate novel ways, inspired by quantum-mechanical systems, to efficiently navigate the energy landscapes of spin glasses in classical algorithms, which has the potential of preventing the simulations getting stuck into local energy minima and thus reaching more optimal solutions.

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Thesis Director: Prof. Dr. Maciej Lewenstein, Dr. Jose Ramon Martinez and Dr. Przemysla Ryszard Grzybowsi
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