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SEMINAR

Solving discrete optimisation problems with a variational quantum-inspired algorithm

Prof Vincenzo Savona (Center for Quantum Science and Engineering, EPFL, Switzerland)

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Venue: Online and Physics Seminar Room, Stellenbosch University

ABSTRACT

Since the 1980s, quantum mechanics has undergone a remarkable transition from solely a theoretical framework of fundamental science to a domain rich with technological applications. Among these, a prominent example is the application of quantum mechanics to speed up the solution of complex optimisation problems, ubiquitous across fields such as engineering, industrial processes, finance, or healthcare. Despite most discrete optimisation problems being computationally hard, the quantum annealing protocol and its digital counterpart on quantum computers still promise a considerable advantage with respect to the best classical algorithms serving the same purpose. The key to this advantage is quantum entanglement, which, however, cannot be fully modelled by classical computing.

In this work, we analyse to what extent such benefit can be retained by a classical algorithm taking inspiration from the quantum annealing protocol. With this purpose, we develop a simulated quantum annealing algorithm based on a variational representation of the quantum state. This method partially captures quantum correlations, while remaining computationally feasible and providing significant advantages with respect to state-of-the-art methods. We test our procedure on various benchmark problems and characterise its advantages. We discuss possible applications and further developments, in particular related to hybrid optimisation heuristics.

BIOGRAPHY

Vincenzo Savona holds the position of Associate Professor of Physics at École Polytechnique Fédérale de Lausanne, where he leads the Laboratory of Theoretical Physics of Nanosystems. He also serves as the Director of the EPFL Center for Quantum Science and Engineering.

His research covers several areas of quantum science and technology, including open quantum systems, quantum optics, photonics, quantum information, and quantum computing.

Vincenzo completed his undergraduate studies at the University of Pisa and the Scuola Normale Superiore in Italy. He obtained his PhD from EPFL in 1997. From 1999 to 2002, he was a Marie Curie Postdoctoral Fellow at the Humboldt University in Berlin. Starting in 2002, he held an SNSF Professorship at EPFL, where he was appointed associate professor in 2010. He teaches quantum physics and quantum computing to undergraduate and graduate students in physics and engineering.

As Director of the EPFL QSE Center, he has established partnerships and collaborations with various industries and academic institutions. He collaborates with the GESDA foundation and the Open Quantum Institute to develop use cases of quantum computing for the UN sustainable development goals, such as zero hunger through optimisation of food systems.

His work bridges fundamental research in quantum physics with applied fields, focusing on the potential for early industrial applications of quantum technologies. He concentrates on developing new concepts for efficient quantum computing platforms, and quantum and quantum-inspired algorithms for modelling and optimisation.

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