DIPARTIMENTO DI SCIENZE MATEMATICHE E INFORMATICHE, SCIENZE FISICHE E SCIENZE DELLA TERRA
Dottorato di Ricerca in Fisica

Appunti di Fisica '24

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su Microsoft Teams "Seminari di Appunti di Fisica"

Solving discrete optimization problems with a variational quantum-inspired algorithm

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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 optimization problems, ubiquitous across fields such as engineering, industrial processes, finance, or healthcare.

Despite most discrete optimization 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 modeled 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 characterize its advantages. We discuss possible applications and further developments, in particular related to hybrid optimization heuristics.