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Quantum-inspired and Quantum metaheuristic algorithms: Insights and perspectives

Solving complex optimization problems remains, to this day, an area of intense research and a challenge for professionals in science, engineering, and industry. This context motivates the emergence of methods that efficiently deal with very diverse problems: multiobjective, with a large number of constraints, nonlinear or with uncertainty, among others. Bio-inspired and metaheuristic algorithms have been widely and successfully applied to solve complex optimization problems, as these methods are easy to understand and implement as well as free of derivatives, although they are approximate methods that cannot guarantee obtaining an optimal solution.

This work explores the role and potential of quantum computing in improving the performance of metaheuristic algorithms. Currently, there are two main approaches to take advantage of quantum computing in the design of metaheuristic algorithms: the first one is quantum-inspired metaheuristics, in which theoretical concepts of quantum computing are mathematically modeled to improve the characteristics of the developed algorithms. The second one is quantum metaheuristics. In this type of algorithms, unlike quantum-inspired algorithms, the formulation of the algorithms is modified so that either the complete algorithm or some of its operators can be executed on a quantum computer and thus improve its performance. The approaches discussed above are leading to the emergence of a new generation of metaheuristic algorithms whose performance may represent a turning point in the research of this type of algorithms.

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