Solving The Schrödinger Equation with PSO-MBO Optimization Algorithms

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Abstract:

The two-dimensional Schrödinger equation governs a wide range of quantum systems and plays a crucial role in quantum mechanics. However, analytical solutions become intractable for complex potential functions and boundary conditions, requiring numerical or heuristic approaches. This study applies two metaheuristic optimization algorithms—Particle Swarm Optimization (PSO) and Migrating Birds Optimization (MBO)—to solve the two-dimensional Schrödinger equation in bounded domains. The results indicate that both methods effectively converge to near-optimal solutions, with MBO showing slightly higher robustness and stability in multidimensional search spaces. A Python-based implementation is provided to visualize the convergence behavior of both algorithms. The comparison demonstrates that metaheuristic methods can offer efficient and accurate alternatives for solving nonlinear quantum problems, supporting future research on hybrid computational approaches in quantum mechanics.

Keywords:

Metaheuristic optimization, migrating birds optimization, particle swarm optimization, schrödinger equation, quantum mechanics.