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PII: S0098-1354(17)30055-8
DOI: http://dx.doi.org/doi:10.1016/j.compchemeng.2017.01.046
Reference: CACE 5702

To appear in: *Computers and Chemical Engineering*

Received date: 30-7-2016
Revised date: 23-1-2017
Accepted date: 27-1-2017

Please cite this article as: A new optimization method: Electro-Search algorithm, *Computers and Chemical Engineering* (2017), http://dx.doi.org/10.1016/j.compchemeng.2017.01.046

A new optimization method: Electro-Search algorithm

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Highlights

- A novel optimization algorithm is proposed, namely Electro-Search (ES) algorithm.
- The Orbital-Tuner method (OTM) is developed as an innovative self-tuning approach.
- The performance of ES algorithm is evaluated by various benchmark test functions.
- The ES algorithm showed superiority over different optimization algorithms.
- The ES algorithm outperformed other algorithms in real-world industrial problems.

Abstract

Natural phenomena have been the inspiration for proposing various optimization algorithms such as genetic algorithms (GA), particle swarm optimization (PSO) and simulated annealing (SA) methods. The main contribution of this study is to propose a novel optimization method, Electro-Search algorithm, based on the movement of electrons through the orbits around the nucleus of an atom. Electro-Search (ES) algorithm incorporates some physical principals such as Bohr model and Rydberg formula, adopting a three-phase scheme. In the atom spreading phase, the atoms (i.e., candidate solutions) are randomly spread all over the molecular space (i.e., search space). In the orbital transition phase, the electrons jump to larger orbits, aiming for orbits with higher energy levels (i.e., better fitness value). The atoms are then relocated towards the global optimum point in the atom relocation phase, navigated by other atoms' trajectory. Besides, the ES tuning parameters are progressively updated through successive iterations via a self-tuning approach developed, namely Orbital-Tuner method (OTM). The efficiency of ES algorithm is examined in various optimization problems and compared with other well-known optimization methods. The effectiveness and robustness of ES algorithm is then tested in achieving the optimal design of an industrial problem. The results demonstrated the superiority of the new ES algorithm over other optimization algorithms tested, and outperforms current optimization algorithms in real-life industrial optimization problems.