Metaheuristic techniques for conformational search

ABSTRACT

The drawback in conformational search (CS) is in locating the most stable conformation of a molecule with the minimum potential energy based on a mathematical function. The number of local minima grows exponentially with molecular size and this makes it that more difficult to arrive at a solution. It had been confirmed that CS belongs to the category of NP-hard (non-deterministic polynomial time) problem. Such complexity requires an equally long amount of time to achieve resolution. This phenomenon is thus known as the 'combinatorial explosion'. Metaheuristic techniques have been constantly used in solving CS problems. These population-based probabilistic techniques explore conformational space by random perturbation of atomic Cartesian coordinates or the torsion angles of rotatable bonds. These methods focus on exploring a search space with maximum efficacy. With one or more solutions in the beginning, metaheuristic method follows with a more iterative approach to optimize the search in promising areas away from local solutions. This method is often employed in circumstances where the exact solution methods are unfeasible within a limited time frame. As such, this paper presents various past metaheuristics approaches that have been brought forth in regards to the problem of an effective exploration of the conformational states of molecular systems. Each metaheuristic method is accompanied by its advantages and disadvantages. The concepts of each approach will be explained and their respective applications are discussed.

Keyword: Model building methods; Distance geometry; Smoothing methods; Systematic search