Depth Proposal
Depth Area: Soft Computing
Depth Topic: Swarm Intelligence in Bioinformatics

by

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Research problems in bioinformatics require the use of advanced soft computing techniques for processing huge amounts of uncertain biological data. Swarm Intelligence (SI) has recently emerged as a family of nature inspired algorithms that are capable of producing low cost, fast, and reasonably accurate solutions to several complex problems [1-5]. These algorithms are motivated by the collective social behavior of a group of unsophisticated organisms; such as, ants, bees, birds, termites, etc. Although these organisms have very limited individual capability, they can cooperatively interact together to perform many complex tasks necessary for their survival. The most two popular SI-based algorithms are Ant Colony Optimization and Particle Swarm Optimization.

Ant Colony Optimization (ACO) draws inspiration from the social behavior of ant colonies. It is a natural observation that a group of 'almost blind' ants can jointly figure out the shortest route between their food and their nest without any visual information. Interestingly ants while crawling, deposit trails of a volatile chemical substance known as pheromone to help other ants to follow its trace. This collective behavior can be described as a series of positive feedback in which the probability of an ant's choosing a path increases as the count of ants that already passed by that path increases. ACO has been found to be both robust and versatile in handling a wide range of optimization problems [6-10].

Particle Swarm Optimization (PSO) is inspired by the social behavior of birds within a flock. Particles are conceptual entities that fly through the multi-dimensional search space. At any particular instant, each particle, or individual, has a position and a velocity. The position vector of a particle with respect to the origin of the search space represents a trial solution of the search problem. The changes to a particle within the swarm (a set of particles) are influenced by the experience of its neighbors, allowing the wisdom to emerge, rather than trying to impose it [11-13]. Unlike most soft computing techniques, PSO does not need gradient information of the objective function. Due to this simplicity, many variants of PSO have been developed and applied in various studies. Moreover, PSO is known as a fast and accurate global optimization method; thus, it may be used, for example, in searching phase of the ab initio approach to protein tertiary structure prediction in order to enhance the performance of the entire process.

For the past few years, there has been a slow, yet steady increase of research papers reporting the successful application of SI-based algorithms in several bioinformatics tasks; such as, microarray data clustering, multiple sequence alignment and protein structure prediction [14-18]. Protein contact maps seem to be another promising application of SI-based algorithms in bioinformatics. These low cost, fast, and reasonably accurate algorithms may help to identify similar long-range contacts between contact map pairs. Long-range contacts are the most uncertain, yet important contacts that exist at the off-diagonal area of protein contact maps. The identification of common long-range contacts between pairs of contact maps could potentially be used as building blocks of a bottom-up approach for protein structure prediction.

In conclusion, Swarm Intelligence is a recent topic in the area of soft computing and computational intelligence, with many interesting applications still to be explored especially in bioinformatics.

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