Ant Colony Optimization

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Ant Colony Optimization (ACO) is a stochastic local search method that has been inspired by the pheromone trail laying and following behavior of some ant species [1]. Artificial ants in ACO essentially are randomized construction procedures that generate solutions based on (artificial) pheromone trails and heuristic information that are associated to solution components. Since the first ACO algorithm has been proposed in 1991, this algorithmic method has attracted a large number of researchers and in the meantime it has reached a significant level of maturity. In fact, ACO is now a well-established search technique for tackling a wide variety of computationally hard problems.

The vast majority of the available ACO applications concern NP-hard combinatorial optimization problems and, among these, mainly those with only one single objective. However, many realistic problems involve two or more, typically competing objective. Therefore, it is not surprising that several researches have investigated the extension of ACO algorithm to handle multiple objective functions. These approaches range from applications to problems with lexicographically ordered objectives to problems that are tackled in the Pareto sense.

In this tutorial we will first give an overview of ACO, highlighting its inspiring source, the main algorithmic variants, and the main application areas. The core part of this tutorial then reviews ways of how ACO algorithms can be used to tackle multiobjective *combinatorial* optimization problems (MCOPs). We will review the main approaches that have been proposed so far with a special emphasis on the application to MCOPs that are tackled in the Pareto sense. In fact, there exists a large number of degrees of freedom for the algorithm designer when applying ACO algorithms to MCOPs. These range from the use of one or several pheromone matrices, the usage of one or several ant colonies, variations on the pheromone update schemes, the usage or not of local search procedures and so on. We will support our discussion with results obtained from some experimental analyses for conceptually simple multiobjective problems such as the multiobjective quadratic assignment problem and the multiobjective traveling salesman problem.

Reference

1. Dorigo, M., Stützle, T.: Ant Colony Optimization. MIT Press, USA (2004)

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