INTERACTED MULTIPLE ANT COLONIES FOR SEARCH STAGNATION PROBLEM

By

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To my dearly loved wife Sana
and
my beloved kids Fatima, Hussein , Mohammed and Abdullah

Abstract

Ant Colony Optimization (ACO) is a successful application of swarm intelligence. ACO algorithms generate a good solution at the early stages of the algorithm execution but unfortunately let all ants speedily converge to an unimproved solution. This thesis addresses the issues associated with search stagnation problem that ACO algorithms suffer from. In particular, it proposes the use of multiple interacted ant colonies as a new algorithmic framework. The proposed framework is incorporated with necessary mechanisms that coordinate the work of these colonies to avoid stagnation situations and therefore achieve a better performance compared to one colony ant algorithm.

The proposed algorithmic framework has been experimentally tested on two different *NP*-hard combinatorial optimization problems, namely the travelling salesman problem and the single machine total weighted tardiness problem. The experimental results show the superiority of the proposed approach than existing one colony ant algorithms like the ant colony system and max-min ant system. An analysis study of the stagnation behaviour shows that the proposed algorithmic framework suffers less from stagnation than other ACO algorithmic frameworks.

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DECLARATION

I declare that all the works described in this thesis was undertaken by myself (unless otherwise acknowledged in the text) and that none of the work has been previously submitted for any academic degree. All sources of quoted information have been acknowledged through references.

Alaa Aljanaby

January, 2010

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List of Abbreviations

ACO	Ant Colony Optimization
ACS	Ant Colony System
AS	Ant System
AS_{rank}	Ranked Ant System
ATSP	Asymmetric Traveling Salesman Problem
BWAS	Best-Worst Ant System
IMACO	Interacted Multiple Ant Colonies Optimization
JSP	Job Scheduling Problem
LBTAS	Local Best Tour Ant System
MACO	Multiple Ant Colonies Optimization
MACS	Multiple Ant Colony System
MMAS	Max-Min Ant System
QAP	Quadratic Assignment problem
SMTWTP	Single Machine Total Weighted Tardiness Problem
SOP	Sequential Ordering Problem
TSP	Traveling Salesman problem
VRP	Vehicle Routing Problem
VRPTW	Vehicle Routing Problem with Time Window

Chapter 1

Introduction

Optimization is the process of finding the best element from a set of available alternatives. An optimization problem consists of an objective function to be minimized or maximized, set of variables that affect the value of the objective function and set of constraints on the value of the variables (Chong & Zak, 2008).

Combinatorial optimization problems are the class of hard optimization problems that have great importance in research and development. These problems have a discrete set of feasible solutions and the goal is to find the optimal solution (the best solution from the feasible solutions). These problems are theoretically proven as Non-deterministic Polynomial (*NP*) hard problems, which mean that there is no exact algorithm that can solve them in a polynomial time (Blum & Roli, 2003). Table 1.1 shows some of these problems grouped according to type of problem. The only way to tackle these problems is to use approximate (heuristic) algorithms such as tabu search, evolutionary computation, simulated annealing, genetic algorithms and recently Ant Colony Optimization (ACO).

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