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Iteration Strategy and its Effect Towards the Performance of Population Based Metaheuristics

Nor Azlina Ab. Aziz
Faculty of Engineering & Technology
Multimedia University
Melaka, Malaysia
azlina.aziz@mmu.edu.my

Nor Hidayati Abdul Aziz
Faculty of Engineering & Technology
Multimedia University
Melaka, Malaysia
hidayati.aziz@mmu.edu.my

Azlan Abd. Aziz
Faculty of Engineering & Technology
Multimedia University
Melaka, Malaysia
azlan.abdaziz@mmu.edu.my

Tasiransurini Abdul Rahman
Department of Electronic Engineering,
Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Johor, Malaysia
surini@uthm.edu.my

Wan Zakiah Wan Ismail
Faculty of Engineering and Built Environment,
Islamic Science University of Malaysia,
Negeri Sembilan,Malaysia
drwanzakiah@usim.edu.my

Zuwairie Ibrahim
College of Engineering,
Universiti Malaysia Pahang
Pekan, Pahang
zuwairie@ump.edu.my

***Abstract*—Metaheuristics algorithms solve optimization problems by repeating a set of procedures. The algorithms can be categorized based on number of agents, either single agent algorithms which are also known as single solution metaheuristics or multi agents algorithms, also known as population-based metaheuristics. In single solution based algorithms, the steps are executed one by one by the single search agent. However, the sequence of the procedures execution with respect to members of a population becomes an issue in population-based algorithms. This issue is governed by iteration strategy, which affects the flow of information within the population. The effect of iteration strategy is studied here. This is an important issue to be considered when designing a new population- based metaheuristic. Three parent algorithms, namely, particle swarm optimization (PSO), gravitational search algorithm (GSA), and simulated Kalman filter (SKF) are used in this work to find a general pattern of the effect of iteration strategy towards the performance of population-based algorithms. Here, the effect of iteration strategy is studied using the CEC2014's benchmark functions. The finding shows that iteration strategy can influence the performance of an algorithm and the best iteration strategy is unique to its parent algorithm. A researcher developing a new population-based algorithm need to identify the best strategy so that the performance of the algorithm proposed is maximized.**

Keywords—Iteration strategy, Asynchronous update, Synchronous update, Population-based metaheuristics.

I. INTRODUCTION

Metaheuristics is iterative procedure that combines exploration and exploitation strategies in order to solve optimization problems [1]. The algorithms can be categorized as single solution based or population-based metaheuristics according to the number of agents used to search for optimal solution. Population-based metaheuristic algorithms use a group of agents to search for the optimal solution. These agents look for the solution through information sharing. The population does not have any central control. The general procedures of metaheuristic algorithms, applicable for both single solution based and population-based, are shown in the pseudo code in Fig. 1. A population's iteration strategy differentiates how the population goes through step 2 and 3 of the pseudocode.

Traditionally, the iteration strategy of the population-based algorithm can be categorized into synchronous and asynchronous update. In a synchronous update, the execution of the procedures is group oriented, where the agents' evaluation in step 2 is carried for the whole population prior to execution of step 3 by the entire population. On the other hand, in an asynchronous update, these steps are viewed as individual tasks. After an agent completes its fitness evaluation, its new solution is immediately generated without the need to wait for other agents in the population to complete their evaluation. This differentiates how information flows between populations that adopt the two different iteration strategies. The difference between the flow of information can affect the exploration and exploitation of a population.

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1:  Random initialization of possible solutions
2:  Current solutions evaluation
3:  Generation of next possible solutions according to
    each metaheuristic rules
4:  If not stopping condition repeat step 2&3, else end the
    algorithm and report the best found solution
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Fig. 1. General Steps of Metaheuristic

Although the iteration strategy is a fundamental aspect of population-based metaheuristics, lack of works had been reported that focus on this issue. Therefore, this work aims to investigate the importance of choosing the most suitable iteration strategy when developing a new population-based metaheuristic algorithm. Three population-based algorithms are selected as the parent algorithms in this study. The algorithms are, particle swarm optimization (PSO) [2], gravitational search algorithm (GSA) [3] and simulated Kalman filter (SKF) [4]. The synchronous and asynchronous update are applied to the parent algorithms. The effect of the iteration strategies is investigated using CEC2014's benchmark functions. The performance of the algorithms is statistically analysed.

In the next section the two traditional iteration strategies, synchronous update and asynchronous update are reviewed. This is followed by introduction of the parent algorithms in section 3. The experiments and results are presented in section 4 and 5 respectively. Finally, in section 6 the work is concluded.