Chapter 3
Bat Algorithm With Generalized Fly for Combinatorial Production Optimization Problems: Case Studies

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ABSTRACT

A set of metaheuristics has proved its efficiency in solving rapidly NP-hard problems. Several combinatorial and continuous optimization areas drew profit from these powerful alternative techniques. This chapter intends to describe a discrete version of bat algorithm (BA) combined to generalized walk evolutionary (GEWA), also called bat algorithm with generalized fly or walk (BAG) in order to solve discrete industrial optimization. The first case of study is the well-known hybrid flow shop scheduling. The second one concerns the operating theatre that represents a critical manufacturing system, as the products delivered are patients. The last problem is the redundancy optimization (ROP) for series-parallel multi-state power system (MSS). Its resolution involves the selection of components with an appropriate level of redundancy to maximize system reliability with constrained cost. A universal moment generating function (UMGF) is used to estimate reliabilities. The modified bat algorithm on specific benchmarks was compared with the original one, and other results taken from the literature of each case study.

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INTRODUCTION

Intelligent methods as fuzzy logic (Ahmed et al.,2017), neural network (Chatterjee et al.,2017a,b), multi agent and particularly metaheuristics (Straub, 2014, Imanirad et al. 2013) are increasingly becoming the key instrument for solving optimization problems in different decision-making levels. The problems can concern reliability and availability (Russell et al. 2009, Damerdji et Noureddine, 2017, Tyagi et al., 2017), resources planning (Filho et al.2014, Hanafizadeh et al.,2009) and tasks scheduling. They appeared in different areas either:

- Public healthcare systems and medical data (Tapia et Corchado, 2009, Walsh et al. 2011, Sharma et al., 2017,Mokeddem et al. 2014, Dey N. et al.,2014; Dey et Ashour, 2017);
- Antenna design ((dey et Ashour, 2016) ;
- Power systems as in (Altaleb et Brodsky, 2013, Kaliannan et al.,2016) and in (Jagatheesan et al., 2017 a, b, c, d) where authors used particles swarm optimization, flower pollination, firefly algorithm and other bio-inspired methods;
- Data mining (Karaa et al.,2016) or
- Manufacturing systems (Dekhici et Belkadi,2017).

Reader can refer to recent literature review of application of metaheuristic (Dey Nilanja.,2018).

Nature inspired swarm metaheuristics as Cross Entropy Dynamic Group Optimization (Tang et al.2017), ant colony, bee, firefly, and bat algorithms are ones of those intelligent methods that are widely attracting researchers. Artificial swarms became the forefront of the current studies due their efficient way to treat NP-hard combinatorial optimization.

In this chapter, a recent hybridized swarm metaheuristic based on the Bat algorithm (BA) and the Generalized Walk Evolutionary (GEWA) which is Bat Algorithm with Generalized Walk (BAG), is described. Inspired from micro-bats echolocation behavior, the Bat Algorithm has the advantage to enhance the best solutions in different ways with different probabilities whereas the Generalized Walk Evolutionary algorithm as walkers' behavior has the advantage to change the worst solution from the population with generalized walk.

Three study-cases will highlight the discretization feasibility of the main presented algorithm. First, the mono processor Hybrid Flow Shop problem is investigated. It is as many of manufacturing systems scheduling one of the NP-hard combinatorial problems that need an effective approximate method to be resolved.

A not far extension of manufacturing system optimization studied in this work is the operating theatre constrained scheduling. It concerns the assignment of patients to different operating rooms and to different recovery beds in Post Anesthesia Unit Care (PACU). The sequencing can take into account some sequencing constraints. Dedicate resources constraints can reduce the configuration to a parallel machine shop.

The third study case is the electrical structure optimization of series-parallel multi-state power production systems. The electrical system components are selected from a list of available components on the market. Electrical components are characterized by their reliability, cost and performance (capacity). An approach based on Universal Moment Generating Function (UMGF) determines the maximal reliability of series-parallel electrical topology of power system and is used under an upper cost bound.