Chapter 16
Usage of Metaheuristics in Engineering: A Literature Review

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ABSTRACT

A metaheuristic is conventionally described as an iterative generation process which guides a servient heuristic by combining intelligently different concepts for exploring and exploiting the search space, learning strategies are used to structure information in order to find efficiently near-optimal solutions. In the literature, usage of metaheuristic in engineering problems is increasing in a rapid manner. In this study; a survey of the most important metaheuristics from a conceptual point of view is given. Background knowledge for each metaheuristics is presented. The publications are classified with respect to the used metaheuristic techniques and application areas. Advantages and disadvantages of metaheuristics can be found in this chapter. Future directions of metaheuristics are also mentioned.

1. INTRODUCTION

Metaheuristics are developed to deal with complex optimization problems where other optimization methods have failed to be either effective or efficient. These methods are known as one of the most practical approaches for solving many complex problems. This is particularly true for the many real-world problems that are combinatorial in nature. Consequently; the field of metaheuristics for the application to combinatorial optimization problems is a rapidly growing field of research. This is due to the importance of combinatorial optimization problems for the scientific as well

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as the industrial world. The practical advantage of metaheuristics lies in both their effectiveness and general applicability (Ólafsson, 2006).

Metaheuristics are widely used for the solution of engineering problems. In the literature, some application areas are observed in ecological modeling, flow-shop scheduling, image processing, vehicle routing problem, assembly line balancing, energy forecasting, forecasting stock markets and etc. Figure 1 shows the frequencies of usage of each metaheuristic technique with respect to the publication years. From 2007 to 2011, approximately a ten times increase in the usage frequencies is observed.

Blum et al. (2011) provide a survey of some of the most important lines of hybridization. Their literature review is accompanied by the presentation of illustrative examples. They emphasize that research in metaheuristics for combinatorial optimization problems has lately experienced a noteworthy shift towards the hybridization of metaheuristics with other techniques for optimization. At the same time, the focus of research has changed from being rather algorithm-oriented to being more problem oriented.

To the best of our knowledge, there is not a recent work on the classification of the publications metaheuristics. The contribution of this chapter is to classify the publications on metaheuristics in engineering in the literature with respect to application problems and areas together with their authors.

The organization of the rest of this chapter is as follows. Section 2 summarizes metaheuristic techniques in engineering. Section 3 gives findings and discussions and the last section gives conclusions and future directions.

2. METAHEURISTIC TECHNIQUES IN ENGINEERING

In this section, metaheuristics techniques will be explained in a conceptual point of view. Additionally, a classification of each technique according to application problems and areas is presented.

2.1 Artificial Neural Networks

2.1.1 Networks

An efficient way of solving complex problems is following the lemma "divide and conquer". A complex system may be decomposed into simpler elements, in order to be able to understand it. Also simple elements may be gathered to produce a

Figure 1. Usage frequencies of each metaheuristic technique from 2007 to 2011