

## Chapter 52

# Metaheuristic Techniques for Test Case Generation: A Review

**Rashmi Rekha Sahoo**

*ITER College, Siksha 'O' Anusandhan University, Bhubaneswar, India*

**Mitrabinda Ray**

*ITER College, Siksha 'O' Anusandhan University, Bhubaneswar, India*

### ABSTRACT

*The primary objective of software testing is to locate bugs as many as possible in software by using an optimum set of test cases. Optimum set of test cases are obtained by selection procedure which can be viewed as an optimization problem. So metaheuristic optimizing (searching) techniques have been immensely used to automate software testing task. The application of metaheuristic searching techniques in software testing is termed as Search Based Testing. Non-redundant, reliable and optimized test cases can be generated by the search based testing with less effort and time. This article presents a systematic review on several meta heuristic techniques like Genetic Algorithms, Particle Swarm optimization, Ant Colony Optimization, Bee Colony optimization, Cuckoo Searches, Tabu Searches and some modified version of these algorithms used for test case generation. The authors also provide one framework, showing the advantages, limitations and future scope or gap of these research works which will help in further research on these works.*

### INTRODUCTION

Generation of test cases is one of the key steps of software testing task. Automatic test case generation can reduce the time of the testing process. Nature inspired algorithms play an important role in automatic/ semi-automatic generation of suitable test cases for a software. The main aim of evolutionary testing is to achieve high degree of automation with quality tests in low cost (Kumar et al., 2011). Exhaustive

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testing is impossible as the solution domain (number of possible test cases for a software under test) is very huge or may be infinite. So, it is required to select the test cases that find out maximum faults with greater coverage and minimum cost. An optimization problem means to find a best solution from all possible solutions. To avoid the so-called problems of time, cost and efficiency, test suite with minimum number of test cases should be designed to achieve maximum coverage (code / requirements coverage), maximum fault detecting capability/ mutant killing score with minimum execution efforts and cost. So, test cases optimization can be defined as a multi objective optimization problem (Roshan et al., 2012). It cannot be solved in combinatorial time and hence it is a Np-hard problem (McMinn, 2011). These types of problems are solved satisfactorily using metaheuristic searching techniques. Some of the optimization techniques that have been successfully applied to test data generation are Genetic Algorithm, Tabu Search, Ant Colony Optimization, Particle Swarm Optimization, Cuckoo Search, Hill Climbing, Simulated Annealing etc. (Harman et al., 2015). In this paper, the strengths and weaknesses of the existing work in the said methods have been identified and future research directions has been suggested.

This paper is organized as follows: This paper provides a Section on the background study of several existing metaheuristic techniques and some widely used test case generation techniques. Next Section presents a systematic review on various search based testing methods. After systematic review, there is a Section containing comprehensive outline of our review. Then, the conclusion is presented in the end Section.

## **BACKGROUND**

### **Meta Heuristic Search Based Techniques**

A metaheuristic is a higher-level procedure to find a heuristic to provide a sufficiently good solution to an optimization problem, especially with incomplete or imperfect information or limited computation capacity (Harman et al., 2007). According to search strategies, it can be classified as local search and global search methods. Global algorithms make balance between exploration and exploitation of the search space by providing globally best solution. These algorithms terminate when a user defined stopping criteria is met. Unlike global search algorithm, local search algorithms do not give emphasis to exploration. They try to find a good solution among the neighbouring solutions. These algorithms terminate when they do not get any better neighbour solution and hence becomes locally optimal (Leonora et al., 2009) (see Figure 1).

In this section, some most widely used local search algorithms like Hill Climbing (HC), Tabu Search (TS) and Simulated Annealing (SA) and global search algorithms like Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Artificial Bee Colony (ABC) and Cuckoo Search (CS) are discussed. Also, their advantages and disadvantages and their application in suitable problems are mainly focused.

### **Local Search Methods**

Hill Climbing is an iterative algorithm that starts with a random solution to a problem, then attempts to find a better solution by incrementally changing a single element of the solution (Ali et al., 2010). The major disadvantage is its maximum probability of getting stuck at a poor local optimum. An alternative

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