Chapter 38
Automatic Test Data Generation Using Bio-Inspired Algorithms:
A Travelogue

Madhumita Panda
North Orissa University, India

Sujata Dash
North Orissa University, India

ABSTRACT

This chapter presents an overview of some widely accepted bio-inspired metaheuristic algorithms which would be helpful in solving the problems of software testing. Testing is an integral part of the software development process. A sizable number of Nature based algorithms coming under the per- view of metaheuristics have been used by researchers to solve practical problems of different disciplines of engineering and computer science, and software engineering. Here an exhaustive review of metaheuristic algorithms which have been employed to optimize the solution of test data generation for past 20 -30 years is presented. In addition to this, authors have reviewed their own work has been developed particularly to generate test data for path coverage based testing using Cuckoo Search and Gravitational Search algorithms. Also, an extensive comparison with the results obtained using Genetic Algorithms, Particle swarm optimization, Differential Evolution and Artificial Bee Colony algorithm are presented to establish the significance of the study.

INTRODUCTION

It would not be wrong to say that software has become the life line of our human civilization and like electricity we cannot survive without it. As the quality of software is playing the crucial role in determining the user's satisfaction therefore it is becoming more and more crucial for the software development team to build the product right. Out of the several phases of software development life cycle the most

important phase is the testing phase which ensures the correctness as well as the quality of the software before release.

Now a days gradually the complexity of the systems are increasing and the software handling those complex systems needs to be error free, safe, secure and reliable from the users perspective. The competing market is influencing testers to implement new approaches, methodologies and strategies to enhance quality and reduce the testing time and development cost of systems. Test case selection and optimization is an NP complete problem. Therefore cannot be solved using existing heuristic algorithms.

Till data a number of metaheuristic algorithms have been proposed, that are nature based search algorithms designed by observing the natural process of evolution followed by nature as well as the intelligent selection and search strategies adopted by natural species for better adaption to their habitat as well as selection of best offspring to carry forward their races to the next generation. Metaheuristic bio inspired algorithms have been used by different researchers in their respective fields of engineering and mathematics for obtaining optimized and best results within a particular period of time or satisfying certain predefined constraints. Some of the most popular and widely used metaheuristic algorithms specifically in the field of software engineering include Genetic Algorithms (GA), Particle swarm optimization (PSO), Artificial Bee Colony algorithm (ABC), Firefly algorithm and Cuckoo Search Algorithm (CS).

A recent area of software testing has emerged in last few decades known as search based software testing (SBST) where the researchers are applying metaheuristic optimization algorithms to solve the critical problems of software testing(De Oliveira, 2015). More than fifty percent of research work of this area involves test data generation using Genetic Algorithms (GA), Particle swarm optimization (PSO), Artificial Bee Colony algorithm (ABC), and multiobjective Genetic Algorithms for performing structural, functional and mutation testing.

The proposed work emphasizes on giving an overview of the automated process of test data generation using metaheuristic algorithms for unit testing of structured programs, targeting complete path coverage of the program under test.This chapter is organized into following sections, Section 2 presents the basic techniques applied to software testing and test data generation, Section 3 gives an exhaustive review of the existing literature, especially in the field of test data generation Section 4 describes a detailed overview of the Bio-inspired metaheuristic algorithms including Genetics Algorithms, Particle Swarm optimization Algorithm, Differential Evolution Algorithm, Artificial bee colony algorithm, Gravitational search algorithm and Cuckoo Search Algorithm, Section 5 includes our proposed methodology and experimental results finally Section 6 concludes the chapter with future directives and discussions.

BASIC CONCEPTS OF TEST DATA GENERATION

Software testing mainly includes the detailed verification and validation of the entire process of software development ensuring its correctness and quality. In earlier days people were not technical literate and neither well acquainted with the use of software and its underlying technologies. With the passage of time and advent of modern technology gradually program complexity, as well as common user's technical knowledge start growing at an explosive rate. Thus it became mandatory to ensure the quality and correct functioning of each and every specification, before successful lunching of any new software, as well as maintenance of existing software.

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