ABSTRACT

Software Testing is one of the most important processes in Software Development Life Cycle (SDLC) to ensure quality of software product. It typically consumes at least 50% of the total cost involved in software development. In order to get zero-defect quality software, the number of test cases generated needs to be infinite, which is impossible in the real world. Since exhaustive testing is not possible, an optimization approach is needed in the testing process to reduce the amount of resources (in terms of time, cost, man power, system components etc.) required for testing without compromising quality. The importance of software test optimization has increased in recent years due to customers’ need for quick delivery of quality software, reduced software development lifecycle, changing markets with global competition and rapid development of new processes and technologies.

Since software test optimization problem is NP-hard (Non-Polynomial hard), several existing research works on structural testing have employed computationally intelligent techniques such as, artificial intelligence and evolutionary computation methods, to achieve optimization in the testing process. The problems in the existing knowledge based approaches, such as the need for large amount of human intervention, lack of human like intelligence in the decision making process, no or less consideration on quality improvement of test cases, reduction of the size of the test suite and striking up at local optima, have been the motivation factors
for this research work. The framework proposed in this thesis, addresses the said problems in structural testing by utilizing meta-heuristic search approaches based on hybrid intelligence techniques.

The contribution of this research work includes the development of a novel software test optimization framework using intelligent agents and evolutionary computation techniques. It achieves software test optimization in three ways namely test sequence, test case and test suite optimizations using heuristics guided hybrid intelligence based search approaches. Test Sequence Optimization is achieved using intelligent agent based graph searching technique, Test Case Optimization using Hybrid Genetic Algorithm (HGA), and Test Suite Optimization using Artificial Bee Colony Optimization (ABC). To ensure the quality, a set of test adequacy criteria such as, coverage and fault revealing capability of test cases, have been applied in the proposed approaches, while achieving optimization.

Each of the proposed approaches is equipped with heuristics guided decision making algorithms that are constructed as maps in achieving software test optimization. Furthermore, each approach is evaluated with various case studies and the results confirm the effectiveness and feasibility of the proposed approaches.

The outcome of the research work is a prototype tool “IntelligenTester” (Intelligent + Tester = IntelligenTester), which is developed using Java and is registered under Java Research License (JRL). The project description is available in the URL https://intelligentester.
dev.java.net. This tool supports the tasks of generating optimal and near optimal solutions for test sequence, test case and test suite optimizations by applying hybrid intelligence based search approaches.

Hence, a novel software test optimization paradigm equipped with hybrid intelligence based search approaches has been proposed to be capable of reducing the length of the test sequences (up to 50% approx. based on coverage), number of test cases (up to 80.6% approx. based on coverage and mutation score) and size of the test suite (up to 84.7% approx. based on path coverage) when compared to existing approaches, without affecting quality. This in turn reduces the total cost and time needed for the testing activity significantly and also aid in delivering quality software.