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Optimum Test Suite Using Fault-Type Coverage-Based Ant Colony Optimization Algorithm

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ABSTRACT

Software product lines (SPLs) cover a mixture of features for testing software application programs (SPA). Testing cost reduction is a major metric of software testing. In combinatorial testing (CT), maximization of fault type coverage and test suite reduction plays a key role to reduce the testing cost of SPA. Metaheuristic genetic algorithms (GA) do not offer the best outcome for test suite optimization problems due to mutation operation and more required computational time. So, fault-type coverage-based ant colony optimization (FTCBACO) algorithm is offered for test suite reduction in CT. FTCBACO algorithm starts with test cases in test suite and assigns separate ants to each test case. Ants elect the best test cases by updating of pheromone trails and selection of higher probability trails. Best test case path of ant with least time are taken as optimal solutions for performing CT. Hence, FTCBACO technique enriches reduction rate of test suite and minimizes computational time of reducing test cases efficiently for CT.

KEYWORDS

Combinatorial Testing, Computational Time, Fault-Type Coverage-Based Ant Colony Optimization, Software Product Lines, Test Cases, Test Suite Optimization, Test Suite Reduction Rate, Testing Cost

1. INTRODUCTION

Software testing is one of the most eminent phase of software development. Main target of software testing is to recognize faults and imperfections arise in software product lines under development. Currently, software testing utilizes additional time and cost consumed on software development. While testing time decreases, testing cost may decrease rapidly. Now a days, software may be published without being checked properly due to market pressure and preplan of software developers to save time and reduce cost spent on software development. Hence, software testers should construct best test cases that discover most of the faults and defects in the software product within the scheduled testing time. Interactions between the pair of features play a key role for constructing best test cases. Combinatorial testing is one of software testing technique to find the interactions between the pair of features in software product line. Additionally, CT reduces the quantity of pair of feature combinations required to check software system excellence as compared to exhaustive testing. Test suite optimization plays essential role to reduce the testing cost of SPA without corrupting their quality factors in CT. So, this investigation work aims test suite optimization proficiently for increasing the ability of CT.

To conduct this research, we have found two different heuristic algorithms called algorithm (Li at el., 2007) Greedy Strategy based and (M.Bharathi & V.Sangeetha, 2019) Genetic algorithm(GA) as baseline algorithms. In Greedy approach (Li at el., 2007), test cases are assembled in downward order

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based on their fault coverage ability and start with test cases that cover maximum amount of faults till either all the faults are reported or test adequacy condition is met. Genetic algorithm (M.Bharathi & V.Sangeetha, 2019) reduces the test cases in test suite yet it does not deliver optimal solution for test suite optimization problem due to mutation operation. Moreover, GA involves several operations like fitness evaluation, selection, crossover, mutation. As an outcome, high computational time is required for test suite optimization problem.

To resolve the above quoted issues in test suite optimization problem using GA, novel Fault-Type Coverage Based Ant Colony Optimization (FTCBACO) algorithm Technique is proposed. FTCBACO algorithm is constructed based on highest faults-type coverage analysis and find an efficient optimum results. The main contribution of proposed technique is,

- To enrich the capability of test suite reduction for CT.
- To rise the test suite reduction rate and to cut the computational time of CT compared with genetic algorithm.
- To optimize test cases in test suite in terms of utmost faults type coverage and least execution time.

The research work of this paper is drawn as follows. An overview of related work is presented in Section 2. Section 3 explains proposed FTCBACO for test suite optimization problem. Section 4 exhibits the experimental settings. Section 5 reports the outcomes and discussions. In section 6, we conclude this paper.

2. RELATED WORKS

A several investigation works have been designed to resolve the test suite optimization problems in combinatorial testing. proposed Similarity-based test suite reduction for model-based testing was introduced in (Ana Emilia Victor Barbosa Coutinho et al., 2016) . But, this strategy reported poor test suite reduction rate. A regression based test case selection method with aim of shrinking the quantity of test cases for regression testing was introduced in (Tamal Sen & Rajib Mall, 2012). But, it required more time to optimize the test cases in a test suite. Several procedures have reviewed for test suite minimization for improving the quality of software metrics in (Shilpi Singh & Raj Shree, 2016).

A hierarchical clustering approach was proposed in (Fayaz Ahmad Khan et al., 2015) for increasing the minimization of test cases in a test suite. However, an optimized test suite does not deliver complete fault reportage. A fuzzy logic based approach was presented in (Haider at el., 2014) for accomplishing test suite optimizations with multi objective. But, test suite optimization demanded higher time complexity. The priority based test case reduction was presented cost in (Jyoti Prakash Rout at el., 2013) with the aim of reducing the testing. But, more testing cost was needed. A unified method was presented in (Srividhya Jeyaprakasha & K.Alagarsamy, 2015) for reducing the test cases and aimed to report the entire faults with least time. But, computational time of test suite reduction was high.

In (Gong Dandan at el., 2013), a two-step test-suite reduction approach was intended to minimize the test cases with the performance of higher fault-localization. But, performance of test-suite reduction was not high. In (Ning Li at el., 2016), an effective strategy to minimize test suite using spectrum-based fault localization was proposed. But, high computational time required for testing excellence of software program. An Artificial Bee Colony algorithm was designed in (Soma Sekhara Babu Lam at el., 2012) for automated generation of independent paths and test suite optimization. But, reduced test suite not covered several pair of features. Adaptive neuro-fuzzy inference system was developed in (Zeeshan Anwar et al., 2015) with grid partitioning to accomplish test suite minimization. However, computational time was not sufficient.

Fault based Genetic algorithm(GA) approach was developed in (M.Bharathi & V.Sangeetha, 2019) to optimize test case for enhancing software quality. But, GA approach demanded more computational