Fuzzy Adaptive Teaching Learning-based Optimization Strategy for Pairwise Testing

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***Abstract*— Pairwise strategies have tested effectively a range of software and hardware systems. These testing strategies offer solutions that can substitute exhaustive testing. In simple terms, a pairwise testing strategy significantly minimizes large input parameter values (or configuration options) of a system into a smaller set based on pairwise interaction (or combination). Fuzzy Adaptive Teaching Learning-based Optimization (ATLBO) algorithm is an improved form of Teaching Learning-based Optimization (TLBO) algorithm. ATLBO employs Mamdani fuzzy inference system to select adaptively either teacher phase or learner phase based on performance instead of blind sequential application as in original TLBO. In this paper, two pairwise testing strategies based on ATLBO and TLBO are proposed. Experimental results suggest that the proposed strategies are capable to be part of testers' toolkit as they outperformed competing meta-heuristic based pairwise testing strategies and tools on many pairwise benchmarks. Moreover, ATLBO based strategy generated optimal pairwise test suites than the one based on TLBO.**

Keywords—software testing; pariwise testing; fuzzy inference system; teaching learning-based optimization

I. INTRODUCTION

Human's dependency on software is increasing with every passing day. Whether it is disease treatment or performing intervention, route finding, communication, entertainment, education, businesses, etc. to name a few, the use of software is inescapable. This leads to the development of more complex and sophisticated software applications. It is now commonplace to have software with dozens or even hundreds of input parameters or configurations options that can have an exorbitant number of combinations [1]. The probability of faults that may arise due to the interaction (or combination) between these parameters or configurations is very high. Exhaustive testing is inefficient or normally impossible. This suggests the need of more efficient sampling testing strategies such as pairwise testing for the quality assurance of these software applications.

Pairwise testing strategies offer efficient and feasible solutions. A pairwise strategy samples fewer possible 2-way interaction or combination of input parameter values or configuration options of a system under test. The generated samples (or test cases) can efficiently substitute testing full-way interaction (i.e., exhaustive testing) of input values [2, 3]. The interaction between each pair of parameter values is accommodated in the test cases at least once [4]. The idea of employing a pairwise testing strategy achieves testing objectives within time and budget constraints. For interaction testing of contemporary software systems, testers may consider a pairwise testing tool or meta-heuristic based strategy an essential part of their toolkit [5].

Teaching Learning-based optimization (TLBO) [6] algorithm is proposed by Rao et al. in 2011 to address global optimization problems efficiently. It is a population based algorithm which performs optimization in two phases: teacher phase and learner phase. In the teacher phase, the algorithm explores the entire search space for quality solutions. In the learner phase, the quality of the obtained solution is evaluated against local solutions. The teacher phase represents global search whereas the learner phase represents local search. Moreover, TLBO only requires control common parameters such as population size and number of iterations in contrast to other meta-heuristics.

Fuzzy adaptive teaching learning-based optimization (ATLBO) [7] algorithm is a most recently proposed optimization algorithm based on Teaching Learning-based optimization (TLBO) algorithm. ATLBO employs the two phases i.e., its global and local search processes, adaptively using Mamdani fuzzy inference system based on quality results. The original TLBO employs the phases sequentially which is sometimes counterproductive i.e., misses potential good solutions. Being new and efficient optimization algorithms for NP-hard problems, this paper adopts ATLBO and TLBO for the pairwise test generation in strategies named pairwise ATLBO (pATLBO) and pairwise TLBO (pTLBO).

The organization of the paper presented in the remainder sections is as follows. Section 2 presents mathematical background of the pairwise test generation problem. Section 3 reviews the current literature about pairwise test generation. Section 4 presents the implementation of the original TLBO as well as the newly developed ATLBO for pairwise test generation problem in the two proposed strategies. Section 5 presents and discusses experimental results and observations.

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