Fuzzy adaptive teaching learning-based optimization strategy for the problem of generating mixed strength t-way test suites

Kamal Z. Zamli, Fakhrud Din, Salmi Baharom, Bestoun S. Ahmed

Keywords: Software testing t-way testing Teaching learning-based optimization algorithm Mamdani fuzzy inference system

1. Introduction

In the past decades, a few meta-heuristic algorithms have been proposed in scientific literature to address real-world optimization problems. These algorithms mainly comprises exploration and exploitation (or diversification and intensification) (Talbi, 2013). Exploration roams the random search space on a global scale (i.e., global search), whereas exploitation focuses on searching in a local region by exploiting the current suitable solution (i.e., local search). Overemphasizing exploration consumes significant computational resources and prevents convergence. Conversely, excessive exploitation tends to deny a diverse solution and may lead toward local optima. Most meta-heuristic algorithms introduce specific parameter controls to manage exploration and exploitation effectively. For example, genetic algorithm (GA) (Holland, 1975) exploits mutation and crossover rate; particle swarm optimization (PSO) (Kennedy and Eberhart, 1995) introduces inertia weight and social/cognitive parameters; harmony search (HS) (Geem, 2009) relies on the consideration rate of harmony memory and pitch adjustment; and ant colony optimization (ACO) (Dorigo et al., 1996) exploits evaporation rate, pheromone influence, and heuristic influence. Tuning the parameters accordingly ensures a suitable quality solution. However, the tuning of these parameters is often time consuming and problem specific because a single size is unavailable to fit all approaches.

The teaching learning-based optimization algorithm (TLBO) (Rao et al., 2011, 2012) adopts a simplistic approach of disregarding the control parameters (i.e., parameter free). TLBO specifically performs both global and local search sequentially per iteration to balance exploration and exploitation. Given that exploration and exploitation are dynamic in nature depending on the current search space region, any preset division between the two can be counter-productive and may lead to poor quality solutions. This paper addresses these issues through a new TLBO variant, adaptive TLBO (ATLBO) integrated with the Mamdani-type fuzzy inference system (Camastra et al., 2015; Cordón, 2011). ATLBO adaptively selects its local and global search operations. In order to assess its performances, we adopt ATLBO for the mixed strength t-way test generation problem. Experimental results reveal that ATLBO exhibits competitive performances against the original TLBO and other meta-heuristic counterparts.

Our contributions are summarized as follows:

- The novel ATLBO strategy based on the Mamdani-type fuzzy inference system is presented for exploration (i.e., global search) and exploitation (i.e., local search) selection.
- ATLBO is the first TLBO-variant strategy that addresses generation for both uniform and mixed-strength t-way test suite.

This study is organized as follows. Section 2 presents the theoretical framework that covers the generation problem of t-way test and its mathematical notation. Section 3 describes the related work. Section 4