A Parameter Free Choice Function based Hyper-Heuristic Strategy for Pairwise Test Generation

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***Abstract*— Hyper-heuristics are advanced high-level search methodologies that solve hard computational problems indirectly via low-level heuristics. Choice function based hyper-heuristics are selection and acceptance hyper-heuristics that use statistical information to rank low-level heuristics for selection. In this paper, we describe a choice function based hyper-heuristic called Pairwise Choice Function based Hyper-heuristic (PCFHH) for the pairwise test generation problem. PCFHH uses a combination of three measures to select and apply an effective low-level heuristic from a set of four low-level heuristics at any stage of the search. Our experimental results have been encouraging as PCFHH outperforms most of pairwise test generation strategies on many of the problem instances.**

Keywords—software testing, pairwise testing, hyper-heuristic, meta-heuristic, choice function

I. INTRODUCTION

Designing a problem independent heuristics or algorithms is difficult. In this direction, researchers adopt methodologies with a general framework such as meta-heuristics that can be applicable to solve problems in different domains. For example, strategies [1-3] based on Genetic Algorithm (GA), simulated Annealing (SA), Particle Swarm Optimization (PSO), etc., have been successfully used as possible solutions for optimization problems in various engineering domains. However, meta-heuristics require extensive knowledge of problem domains in order to provide optimal solutions. To be specific, optimality can only be achieved by making substantial efforts to fine tune the control parameters (or search operators) of these methodologies. Adaptive meta-heuristics, for example [4, 5], can partially address this overhead by automating the tuning process. Hyper-heuristics emerged as efficient search paradigms that can not only avoid the parameter tuning but can also generalize the process of solving different optimization problems.

level heuristic from a set of deployed low-level heuristics dynamically during the search. The selection decision of a heuristic is based on domain independent measures, such as the recent performance of low-level heuristics. This makes hyper-heuristics an elegant alternative to the meta-heuristics which are mostly problem specific and need tuning of their related parameters [12].

In this paper, we examine the application of a choice function based hyper-heuristic as a possible solution for pairwise test generation. In pairwise testing, the aim is to search minimum number of test cases that cover all possible pairwise value combinations between any two parameters of the system under test. In some class of systems, pairwise testing has proven its effectiveness for detecting interaction faults in systems with large configurations, parameters and values.

In the context of the current proposed work, the Pairwise Choice Function based Hyper-Heuristic (PCFHH) is derived from the well-known hyper-heuristic approach [13] based on the choice function. Choice function is the selection mechanism that exploits ranking to select an effective low-level heuristic at any stage of the search process. Choice function based hyper-heuristic collects information about each individual heuristic (recent performance), pairs of heuristics (performance of two heuristics selected in sequence) and inactive heuristics for certain time. This learning enables the hyper-heuristic to select the most effective low-level heuristic from the pool of low-level heuristics dynamically during search. PCFHH employs four low-level heuristics for the problem of generating pairwise test cases. These low-level heuristic search operators are; Genetic Algorithm (GA) [14] crossover search operator, Teaching Learning based Optimization (TLBO) algorithm's [15] peer learning search operator, Flower Algorithm's global pollination (FPA) [16] search operator, and Jaya algorithm's [17] search operator.