Hybrid Test Redundancy Reduction Strategy based on Global Neighborhood Algorithm and Simulated Annealing

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ABSTRACT
Software testing is a critical part of software development. Often, test suite sizes grow significantly with subsequent modifications to the software over time resulting into potential redundancies. Test redundancies are undesirable as they incur costs and are not helpful to detect new bugs. Owing to time and resource constraints, test suite minimization strategies are often sought to remove those redundant test cases in an effort to ensure that each test can cover as much requirements as possible. There are already many works in the literature exploiting the greedy computational algorithms as well as the meta-heuristic algorithms, but no single strategy can claim dominance in terms of test data reduction over their counterparts. Furthermore, despite much useful work, existing strategies have not sufficiently explored the hybrid based meta-heuristic strategies. In order to improve the performance of existing strategies, hybridization is seen as the key to exploit the strength of more than one meta-heuristic algorithm. Given such prospects, this research explores a hybrid test redundancy reduction strategy based on Global Neighborhood Algorithm and Simulated Annealing, called GNA_SA. Overall, GNA_SA offers better reduction as compared to the original GNA and many existing works.

Keywords
Test Redundancy Reduction; Simulated Annealing; Global Neighborhood Algorithm.

1. INTRODUCTION
In line with the customer demands for new functionalities, software lines of code (LOCs) increase tremendously in the last 10 years. As the software application's size changed from kilobytes to gigabytes and terabytes, achieving a high level of reliability will be difficult. As testing can be seen as the gatekeeper for reliability, test engineers will always be under pressure to develop efficient test cases in an effort to ensure sufficient reliability.

In the case of large scale software development involving multiple test engineers, there are potentially many overlapping test cases owing to the evolution of the software over time. The same test cases may be coordinated by different teams, as such, causing potential unwarranted redundancies across the shared modules. Such a problem can be even worse when the development teams are not geographically co-located and in different time zones.

Furthermore, unlike other software development phases, the execution of test cases often happens late towards the end of the software engineering life cycle. As such, owing to the need to meet the deadline, test engineers may not have the luxury of executing all the test cases. In this manner, redundancy reduction may be the way forward to minimize the irrelevant test cases.

There are already significant efforts to develop suitable test redundancy strategies to remove extra testing efforts. General computational strategies (e.g. [1], [2] and [3]) are few of these efforts. Recently, researchers have started to address the test redundancy reduction as an optimization problem [4] As a result, new strategies based on meta-heuristic algorithms have emerged. LAHCS [5] and tReductSA [4] are some examples available in the literature. Although useful, these meta-heuristic strategies do have limitations. Firstly, the No Free Lunch Theorem [6] logically proves that no on single meta-heuristic algorithm can outperform others even when there is a slight change in problem configuration. Secondly, as existing test redundancy strategies mostly dwell on single solution algorithms, the exploration of search spaces is typically limited. As such, the diversity of solutions might be compromised. To address the aforementioned issues, this study proposes a hybridization approach. With hybridization, each algorithm can exploit the strengths and cover the weaknesses of the collaborating algorithms (i.e. either partly or in full). In fact, many recent results from scientific literature (e.g. [7-9]) seem to indicate that hybridization improves the performance of meta-heuristic algorithms. Owing to this alluring prospect, this work proposes a new hybrid strategy for test redundancy reduction problem based on the Global Neighborhood Algorithm (GNA) and Simulated Annealing (SA).

2. PROBLEM DEFINITION MODEL
Table 1 illustrates hypothetically the test cases versus requirements traceability matrix where R1 till R8 denote the requirements and t1 till t5 denote the test cases. Ideally, in real practice, the number of test cases and requirements can be much larger.