Omni-optimizer: A Procedure for Single and Multi-objective Optimization

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Abstract. Due to the vagaries of optimization problems encountered in practice, users resort to different algorithms for solving different optimization problems. In this paper, we suggest an optimization procedure which specializes in solving multi-objective, multi-global problems. The algorithm is carefully designed so as to degenerate to efficient algorithms for solving other simpler optimization problems, such as single-objective uni-global problems, single-objective multi-global problems and multi-objective uni-global problems. The efficacy of the proposed algorithm in solving various problems is demonstrated on a number of test problems. Because of it's efficiency in handling different types of problems with equal ease, this algorithm should find increasing use in real-world optimization problems.

1 Introduction

With the advent of new and computationally efficient optimization algorithms, researchers and practitioners have been attempting to solve different kinds of search and optimization problems encountered in practice. One of the difficulties in solving real-world optimization problems is that they appear in different forms and types. Some optimization problems may have to be solved for only one objective, some other problems may have more than one conflicting objectives, some problems may be highly constrained, and some may have more than one optimal solutions. When faced with such problems, a user first analyzes the underlying problem and chooses a suitable algorithm for solving it. This is because an algorithm efficient for finding the sole optimum in a single-objective optimization problem cannot be adequately applied to find multiple optimal solutions present in another optimization problem. To solve different kinds of problems, a user needs to know different algorithms, each specialized in solving a particular class of optimization problem.

In this paper, we propose and evaluate a single optimization algorithm for solving different kinds of function optimization problems often encountered in practice. The proposed *omni-optimization* algorithm adapts itself to solve dif-

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ferent kinds of problems – single or multi-objective problems and uni or multi-global problems. The motivation for developing such a generic procedure came from the generic programming practices. For example, if a programming task is to develop a code for adding a few integers, a generic approach would be to use the following strategy.

```
Add a few integers:
begin
   print 'enter number of integers to be added', read n
   sum = 0
   for i = 1 to n
      print 'enter integer i', read a[i]
      sum = sum + a[i]
   print 'Sum =' sum
end
```

Interestingly, the same code can be used for adding any number of integers initially defined by the variable n. If $n = 1$ is used (thereby trying to add only one number to zero), the code degenerates to printing the same integer as the outcome of the addition. On a similar vein, a generic optimization procedure should find optimal solutions for a multi-objective optimization problem and the same procedure should degenerate to solving a single-objective optimization problem if only one objective function is used. Similarly, our proposed approach can find multiple optimal solutions, if present in a problem, and will automatically degenerate to find the sole optimum of a uni-global optimization problem.

The proposed omni-optimizer is carefully designed to have various properties needed for solving different kinds of optimization problems and is also found to be computationally efficient. The simulation results on 12 test problems show the usefulness of the proposed algorithm and suggest more such studies in the near future.

2 Function Optimization Problems

A function optimization problem may be of different types, depending on the desired goal of the optimization task. The optimization problem may have only one objective function (known as a single-objective optimization problem), or it may have multiple conflicting objective functions (known as a multi-objective optimization problem). Some problems may have only one global optimum, thereby requiring the task of finding the global optimum[1]. Other problems may contain more than one global optima in the search space, thereby requiring the task of finding multiple such global optimal solutions. Although in some optimization

[1] However, in robust optimization tasks, instead of finding the global optimum, the emphasis is on finding a solution which is less sensitive to local perturbation of variables.