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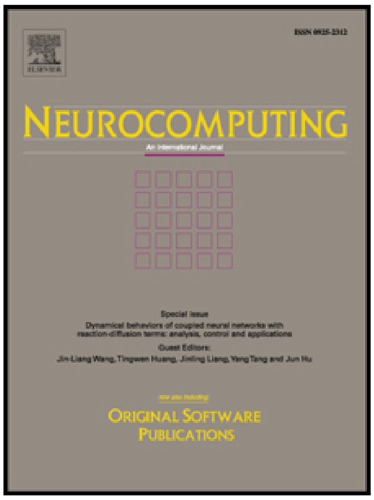

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Decision Maker Iterative-based Framework for Multiobjective Robust Optimization

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Abstract

In design optimization problems, the robustness of a solution is essential to be considered when it is going to be implemented or used in real world. Robustness can be defined in different ways, but in this work, it is considered as the property of a solution's performance to be as insensitive as possible to perturbations in that solution. Optimizing both quality and robustness is generally addressed as a multiobjective problem.

This paper presents a complete framework aided by decision maker, which can be used to solve robust optimization problems with one or more objectives. Decision maker actively takes part of the process, defining *a priori* the robustness metric, and specifying iteratively a *robustness factor* that joins quality and robustness metrics into a single *fitness* function. The framework is very flexible allowing decision maker not only to specify the right robustness level for him, but also to exchange metrics and algorithms if he wants.

The framework was tested and validated using two single-objective robust benchmarking functions, and in one new multiobjective robust function, created to challenge the framework, which tries to seek the most robust Pareto optimal front according to decision maker preferences.

Keywords: Robust optimization; Multiobjective robust optimization; Decision making; Robustness metric; Evolutionary algorithm

1. Introduction

A growing interest in robust optimization was observed in the beginning of this century as remarked by some review papers [1, 2, 3]. With the development of efficient optimization algorithms in the last two decades, it was time to focus on robustness in order to address challenging real world optimization problems under uncertainties. These uncertainties include factors such as data incompleteness, mathematical model inaccuracies, environmental condition variation, and parameter tolerances [2], which results on a poor quality solution that when implemented is not robust.

Uncertainties, either in design variables or in environment, may affect solution performance adversely, but robust optimization considers these effects explicitly and seeks for minimizing the consequences keeping performance in a reasonable level or threshold [4].

Evolutionary algorithms are widely used to solve robust optimization problems [1]. Evolutionary approaches can be categorized into single objective (SO) and multiobjective (MO) optimization approaches. By far, the majority of research activities in robust optimization follows the SO approach [2, 3]. Regarding SO optimization, the goal is to find a robust optimum solution. However, in contrast to SO optimization, it is also essential to obtain a well-distributed and diverse robust solution set in MO optimization.

Motivated by such a finding, we present a novel framework for decision making in multiobjective robust design optimization. In this framework, decision maker (DM) can define either *a priori* or iteratively a parameter $\lambda \in [0, 1]$, called robustness factor, that measures how robust the solution searched in the optimization problem should be. For example, if $\lambda = 1$ the solution is the most robust, whereas if $\lambda = 0$ the solution is the nominal optimal one, and robustness is not considered. If decision maker wants some intermediate solution between the most robust and the most optimum ($0<\lambda<1$), it is up to him to define the best tradeoff. The framework does support decision maker on understanding and visualizing of the tradeoffs involved. Therefore, this methodology defines a straightforward process that facilitates the incorporation of robustness by DM in real optimization problems.

This paper is structured as follows. Section 2 presents the background information, section 3 presents the decision maker and robustness concepts. Section 4 presents the complete framework proposed and explains in detail all parts of it. Section 5 presents a set of analytical problems on which the framework is applied and the results are shown in section 6. Finally, section 7 concludes the present work.

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