



Article

Variable Decomposition for Large-Scale Constrained Optimization Problems Using a Grouping Genetic Algorithm

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Abstract: Several real optimization problems are very difficult, and their optimal solutions cannot be found with a traditional method. Moreover, for some of these problems, the large number of decision variables is a major contributing factor to their complexity; they are known as Large-Scale Optimization Problems, and various strategies have been proposed to deal with them. One of the most popular tools is called Cooperative Co-Evolution, which works through a decomposition of the decision variables into smaller subproblems or variables subgroups, which are optimized separately and cooperate to finally create a complete solution of the original problem. This kind of decomposition can be handled as a combinatorial optimization problem where we want to group variables that interact with each other. In this work, we propose a Grouping Genetic Algorithm to optimize the variable decomposition by reducing their interaction. Although the Cooperative Co-Evolution approach is widely used to deal with unconstrained optimization problems, there are few works related to constrained problems. Therefore, our experiments were performed on a test benchmark of 18 constrained functions under 100, 500, and 1000 variables. The results obtained indicate that a Grouping Genetic Algorithm is an appropriate tool to optimize the variable decomposition for Large-Scale Constrained Optimization Problems, outperforming the decomposition obtained by a state-of-the-art genetic algorithm.

Keywords: Grouping Genetic Algorithm; variable decomposition; Large-Scale Constrained Optimization



Citation: Carmona-Arroyo, G.; Quiroz-Castellanos, M.; Mezura-Montes, E. Variable Decomposition for Large-Scale Constrained Optimization Problems Using a Grouping Genetic Algorithm. *Math. Comput. Appl.* **2022**, *27*, 23. <https://doi.org/10.3390/mca27020023>

Academic Editor: Claudia Schilling

Received: 26 January 2022

Accepted: 1 March 2022

Published: 2 March 2022

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1. Introduction

A constrained numerical optimization problem is defined by finding the vector $\mathbf{x} \in \mathbb{R}^D$ that minimizes the objective function $Obj(\mathbf{x})$ subject to inequality $g_j(\mathbf{x})$ and equality $h_k(\mathbf{x})$ constraints [1]. This is described by Equation (1).

$$\begin{aligned} & \text{minimize} && Obj(\mathbf{x}) \\ & \text{subject to} && \\ & && g_j(\mathbf{x}) \leq 0, \quad j = 1, \dots, q \\ & && h_k(\mathbf{x}) = 0, \quad k = 1, \dots, r. \end{aligned} \tag{1}$$

where q and r represent the number of inequality and equality constraints, respectively, $\mathbf{x} = (x_1, \dots, x_D)$, and the search space S is defined by the lower limits l and upper limits u ($l_i \leq x_i \leq u_i$), while the feasible region is defined as the subset of solutions that satisfy the constraints of the problem $F \subset S$.

To handle the constrained problem, the constraint violation sum cvr [2], is calculated by Equation (2).

$$cvr(\mathbf{x}) = \sum_j^q \max(0, g_j(\mathbf{x})) + \sum_k^r \max(0, |h_k(\mathbf{x})| - \epsilon) \tag{2}$$

Decomposition Of Large Scale Problems

Michael Brown



Decomposition Of Large Scale Problems:

The book delves into Decomposition Of Large Scale Problems. Decomposition Of Large Scale Problems is a crucial topic that needs to be grasped by everyone, from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Decomposition Of Large Scale Problems, encompassing both the fundamentals and more intricate discussions.

1. The book is structured into several chapters, namely:

- Chapter 1: Introduction to Decomposition Of Large Scale Problems
- Chapter 2: Essential Elements of Decomposition Of Large Scale Problems
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- Chapter 4: Decomposition Of Large Scale Problems in Specific Contexts
- Chapter 5: Conclusion

2. In chapter 1, this book will provide an overview of Decomposition Of Large Scale Problems. The first chapter will explore what Decomposition Of Large Scale Problems is, why Decomposition Of Large Scale Problems is vital, and how to effectively learn about Decomposition Of Large Scale Problems.

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4. In chapter 3, the author will examine the practical applications of Decomposition Of Large Scale Problems in daily life. The third chapter will showcase real-world examples of how Decomposition Of Large Scale Problems can be effectively utilized in everyday scenarios.

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6. In chapter 5, this book will draw a conclusion about Decomposition Of Large Scale Problems. This chapter will summarize the key points that have been discussed throughout the book.

The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Decomposition Of Large Scale Problems.

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