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A Review of De Novo Programming

Mega Yumia [1], Febrianto Afli [1*]

[1] Departement of Mathematics, Universitas Palangka Raya, Indonesia.

Abstract

This paper purposes to review the advances in De Novo programming in solving multi-objective problems. In multi-objective optimization, many objectives must be considered simultaneously in decision making, often with conflicts between them. De Novo programming is an interesting approach that focuses on optimizing system design by considering multiple objectives, while keeping in mind budget constraints and resource allocation. The method has been applied in various fields, including production management, transportation planning, and healthcare. Researchers have also enriched De Novo Programming by integrating fuzzy functions to address uncertainty, introducing meta-objective programming to guide decision-making, and proposing min-max and weighted objective programming approaches to improve efficiency in problem solving. With continuous development, De Novo Programming offers the potential to address complex multi-objective optimization challenges and improve the decision-making process in various industries.

Keywords: De Novo Programming Multi Objective Optimization, Resource Allocation.

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INTRODUCTION

A multi-objective problem is a type of optimization problem where there is more than one objective or criterion that must be considered simultaneously to find the optimal solution [1]. In these problems, there is often a conflict or trade-off between the objectives, meaning that an increase in one objective may result in a decrease in another objective. The elements of a multi-objective problem include:

1. Objective function: The objective function is a mathematical expression used to specify what needs to be optimized within a mathematical optimization problem. Essentially, it is the function that is either maximized or minimized in the given problem [2].
2. Constraints function: Constraints are mathematical expressions that serve to restrict the permissible values for the decision variables within an optimization problem. These constraints can take the form of either equality or inequality expressions, and they may involve linear or nonlinear functions of the decision variables [3].
3. Decision variables: Decision variables represent the key variables that are targeted for optimization within an optimization problem. They are the variables upon which the objective function relies and are subjected to the constraints imposed by the problem [4].

The use of optimization in problems with many different objectives has helped us tackle more complicated problems in various fields. It is used in various fields, including product portfolio problem [5], computational design exploration [6], vehicle routing problem [7], land use optimization [8], closed-loop supply chain network design [9], transportation network planning [1], home health care [10], and multi-energy flow coupling system [11].

In technology, it helps us design better systems with cost, safety, and energy efficiency in mind. In manufacturing, it helps companies make high-quality products at a lower cost. In economics, it is used to manage resources wisely, thinking about economic growth, the environment, and society. In business, it helps companies plan the efficient supply of goods. In other words, optimization in a multi-objective problem helps us make better and more sustainable decisions by considering many different factors.

Correspondence Address
E-mail: febrianto.afli@mipa.upr.ac.id

Within the field of optimization problems, De Novo programming is a noteworthy method. It entails the creation of wholly original algorithms or heuristics created especially to handle challenging optimization problems. De Novo Programming offers a methodologically exciting route for exploration within the context of academic discourse and computational science, challenging the limits of conventional optimization techniques.

De Novo programming offers several advantages over conventional decision-making models that involve trade-offs between competing goals. By simultaneously maximizing all relevant objectives, De Novo programming seeks to achieve optimal designs through resource allocation and production process optimization. This comprehensive approach can lead to enhanced productivity and effectiveness in businesses. Unlike traditional models that often prioritize one goal over others, De Novo programming emphasizes finding solutions that excel in multiple areas. This can result in more balanced and favorable outcomes, ultimately leading to improved decision-making in production management. This method is also referred to as the Multi Criteria Solution Procedure (MCSP).

Furthermore, De Novo Programming offers the prospect of not only enhancing computational efficiency but also improving interpretability—a persistent challenge in numerous optimization algorithms. The opacity of many conventional optimization techniques can hinder their adoption in critical domains, such as healthcare, finance, or logistics. Consequently, the motivation for reviewing academic literature on De Novo Programming is rooted in the aspiration to not only achieve optimal solutions but also render these solutions explicable in intricate problem-solving scenarios.

Beyond these immediate issues, the impetus to scrutinize papers on De Novo Programming also stems from the aspiration to stimulate innovation within the realm of optimization research. By examining the latest advancements and insights within this field, researchers can acquire valuable knowledge that may serve as a catalyst for their own investigations. De Novo Programming constitutes an intriguing frontier within the pursuit of optimization excellence, and a comprehensive review of pertinent scholarly literature is imperative for comprehending its potential impact and applicability across diverse domains.

RESULT AND DISCUSSION

De Novo Programming

The de novo program concentrates on optimizing the system design to increase productivity against many objectives [12]. The de novo program solves the optimization problem as a whole, meaning that in addition to determining the best combination that is optimal for the outcome [13], this method also provides a proposal for the integrated use of resources through the available budget due to budget constraints, which is an important requirement in the formulation of de novo programs.

A De Novo program aims to design a constraint function so that the resources are fully utilized or not left over. A de novo program can also be used even if the resource limit or constraint limit of a multi- objective problem is unknown, provided that the per-unit cost of the resources and the total available budget are known. A de novo program also provides equal objective target values for all objectives, so that each objective can be achieved with equal importance. Constructing multi-objective problems into de novo programming introduced by Zeleny [12].

Given a multi-objective problem as follows :

$$\text{maks/ min } z_k = c_{k1}x_1 + ck_2x_2 + \cdots + c_{kn}x_n \qquad k = 1, 2, \dots, n$$

constraints

$$v_1x_1 + v_2x_2 + \cdots + v_nx_n \leq B$$
$$x_1, x_2, x_n \geq 0$$

By solving each objective against the given constraints, we will obtain:

$$c_{k1}x_1 + ck_2x_2 + \cdots + c_{kn}x_n = z_k^* \qquad k = 1, 2, \dots, n$$

z_k^* is the maximum or minimum value of the objective function. Then, we will find the minimum cost required for all objectives to be achieved optimally.

$$\min\,(v_1x_1 + v_2x_2 + \cdots + v_nx_n)$$

constraints

$$c_{k1}x_1 + ck_2x_2 + \cdots + c_{kn}x_n = z_k^* \qquad k = 1, 2, \ldots, n$$
$$x_1, x_2, x_n \geq 0$$

After solving the above problem, we will get the minimum cost to realize all the objectives in the most optimal state. (B^*). Next, calculate the ratio between the available cost to B^*. Suppose $u = B/B^*$. The De Novo Program formula is expressed as follows:

$$c_{k1}x_1 + ck_2x_2 + \cdots + c_{kn}x_n = z_k^* u \qquad k = 1, 2, \ldots, n$$

constraints

$$v_1x_1 + v_2x_2 + \cdots + v_nx_n \leq B$$
$$x_1, x_2, x_n \geq 0$$

The goal of De Novo Programming is to design the objective function structure in mathematical programming in a way that allows the objective or objective function to change dynamically. This approach aims to provide flexibility in designing mathematical models in order to accommodate changes in the objectives or preferences of decision makers without the need to change the entire model structure.

Devolopment of De Novo Programming

De Novo programming is a methodology that was created with the goal of handling complex production problems. Main concern on De Novo Programming is to finding optimum path ratio. Shi [14] constructs some optimum path ratio in addition to Zeleny's. This research proposes several optimum-path ratios for enforcing different budget levels of resources so as to find alternative optimal system designs for solving multicriteria. These alternative optimal system designs can help address the challenges of production management by considering various budget levels and finding the most suitable solutions.

Incorporating fuzzy functions into De Novo programming is one of the main themes of De Novo programming research development. Two studies by Li and Lee [15] [16] incorporate fuzzy coefficients and then fuzzy goals into systems. Chen and Hsieh [17] modify traditional De Novo programming problems to a De-Novo programming problem with multiple fuzzy goals, fuzzy constraints, and multiple stages. Those were then observed as fuzzy, dynamic programming problems. Sasaki et al [18] propose a method for solving an optimal design problem of system reliability with fuzzy goal and fuzzy constraints using Genetic Algorithm. By incorporating fuzzy coefficients and goals into systems, researchers aim to enhance the decision-making process in production management. This approach allows for the consideration of uncertainties and imprecise information, which are common in real-world scenarios. By accounting for these factors, De Novo programming with fuzzy functions can generate more robust and flexible solutions that can adapt to changing conditions. This can lead to more effective decision-making, improved system designs, and ultimately better outcomes in production management.

Umarusman [19] proposed min-max goal programming approach to solve de novo programming multi-objective problems. In their research, positive and negative ideal solutions have been employed within the framework of Goal Programming using the Min-max approach. With this reformulation, our goal was to achieve a satisfactory balance between the best and worst performances of the problem. Furthermore, Banik [20] has suggested the utilization of a Weighted Goal Programming Approach to address Multi-Objective De Novo Programming Problems. In his paper, he introduced a one-step method for solving multi-objective De Novo programming problems (MODNPP). This method involves reducing the number of deviation variables in the reformulation of the problem, hoping to reduce processing time especially on complex problems in solving MODNPP using a weighted goal programming approach.

Zhuang and Hocine [17] propose a meta-goal programming-based approach to solve De Novo programming problems. This approach has been shown to provide better results compared to Zeleny's Multi

Criteria Solution Procedure (MCSP) in specific applications, such as Wind Farm Construction Planning. By incorporating meta-goal programming, which involves setting higher-level goals to guide the decision-making process, businesses can achieve more favorable outcomes for complex production problems. This method shows promise and has the potential for further improvement, making it an exciting avenue for future research and application in De Novo programming.

CONCLUSION

De Novo Programming is an interesting approach to solve multi objective optimization problems. De Novo Programming main goals are to re-design system to give the most efficient solutions, cost-wise. One of main theme of research development about De Novo Programming is to incorporate uncertainty, therefore adding fuzzy functions and ways to solve it to improve traditional De Novo Programming.

Author declaration

Author contributions and responsibilities

The authors made major contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of results. The authors read and approved the final manuscript.

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Availability of data and materials

All data is available from the author.

Competing interests

The authors declare no competing interests.

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