Neutrosophic Mathematical Model of Product Mixture Problem Using Binary Integer Mutant

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Abstract
Linear programming problems with integers, are issues in which some or all decision variables are restricted to be their values are correct values, and here these models can be solved by neglecting the constraints of integers and then rotating the fractional values of the optimal solution to obtain correct values, paying attention to the need for the resulting solution to belong to the accepted solutions area, but this procedure can lead to the desired purpose if the number of variables is small, but if there is a number We do not guarantee to obtain an optimal correct solution for the model, even if all the solution combinations are tested, knowing that in the model that contains a variable $\boldsymbol{n}$, a set of solutions2^n must be tried, and if we can rotate, the correct solution will be an approximate solution, in order to obtain more accurate integer values, we present in this research a study in which we use binary integer variables to build the neutrosophic linear mathematical model. The importance of this study lies in providing solutions to many practical problems that require solutions with integers and we will clarify all of the above by building a mathematical model for the problem of the mixture of products using binary integer variables and neutrosophic values.

Keywords: Process research; Linear models; Integer models; Neutrosophic science; Neutrosophic linear mathematical model; Product mixture problem.

1. Introduction

In practical life, we encounter a lot of mathematical models that do not accept a solution unless the compounds of this solution are correct values, and one of the most important examples of these models is the product mixture model, and a distinction must be made between this model and the model of the installation of mixtures because what is meant by the mixture of products is to choose the appropriate product production from among the range of products that can be produced by a production company, it is clear that the optimal solution compounds must be integers, but in fact when solving such models The values of some or all variables may be incorrect values, which requires us to use methods to approximate them to integer values belonging to the accepted solution area, and the optimal solution is an approximate solution that may cause a loss to the company, and to obtain an accurate ideal solution for such models, use the binary integer variable that takes one of the two values, and here the one agrees with the decision to produce the product and zero the decision not to produce $\delta_j \quad 0 \quad or \quad 1$ [1,2] As a result of this use, we get linear mathematical models Optimal solution compounds have valid values, it should be noted here that this study is identical to the concepts of neutrosophic science because there is no determination in it, we do not know exactly which product we will produce, that is, these models can be considered neutrosophic linear models, also we can here from the concepts contained in the research [3] In addition to the binary variable, we can obtain neutrosophic linear models for the problem of the mixture of products using neutrosophic values with all problem data And some of them, which will enable us to obtain an optimal solution with neutrosophic values, values that the American scientist Florentin Smarandache knew when he introduced his new science neutrosophic science in 1995, a science that grew and developed rapidly thanks to the efforts of those interested in this science and scientific development [4-12].

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2. Discussion:

The profit of any company that can produce a number of products is affected by the optimal choice of products that will produce it from the group of products that it can produce. To help these companies choose the products that bring them the greatest profit, operations research provided linear mathematical models called product mixtures. Since the optimal solution for any linear model may have one or all of its components' incorrect values, the researchers formulated the appropriate model δ_j for such problems. Use the binary integer variable that takes one of the two values $0\ or\ 1$ and here one corresponds to the product production decision and zero non-production decision:

Question text: [1]

A company is planning to produce Nproduct where the product j needs a fixed preparation cost or a fixed production cost K_j independent of the quantity produced, and needs a variable cost $C_j$per production unit commensurate with the quantity produced, suppose that each unit of the product j needs $\boldsymbol{a_{ij}}$ unit of the supplier $i$where there is M supplier and assuming that the product j has a sales opportunity of d_j and is sold at the price P_j of a monetary unit per unit and that only b_j unit of the supplier $\boldsymbol{i}$ is available where $i = 1,2, - - -, M$

The goal of the issue becomes to determine the optimal product mix which makes the net profit the greatest possible

Formulation of the mathematical model:

Determination of the cost:

From the text of the problem, we note that the total cost of production is the fixed cost in addition to the variable cost, which is a nonlinear function of the quantity produced,

But with the help of binary integer variables δ_j , the problem can be formulated in the form of a linear model with integers

We assume that the binary integer variable δ_j symbolizes the decision to produce the product j or not to produce it, in other words:

$$\delta_j = \begin{cases} 1 & j \text{ if production decision was taken} \\ 0 & \text{otherwise} \end{cases}$$

Then the cost of producing one unit of the product j becomes as follows $K_j\delta_j + C_j x_j \delta_j$ where $\boldsymbol{\delta_j = 1}$ if$x_j > 0$ and $\delta_j = 0$ if $x_j = 0$ and therefore the goal function will be written as follows

$$Z = \sum_{j=1}^{N} P_j\, x_j - \sum_{j=1}^{N} (K_j \delta_j + C_j x_j)$$

Limitations of the problem:

A restriction on the supplier i is given in the following relationship:

$$\sum_{j=1}^{N} a_{ij}\, x_j \le b_j \quad ; i = 1,2, - - -, M$$

The restriction of the demand for the product j is given by the following relationship:

$$x_j \le d_j \delta_j \quad ; j = 1,2, - - -, N$$

Mathematical model: find the maximum value of the function

$$Z = \sum_{j=1}^{N} P_j\, x_j - \sum_{j=1}^{N} (K_j \delta_j + C_j x_j)$$

Within Restrictions

$$\sum_{j=1}^{N} a_{ij}\, x_j \le b_j \quad ; i = 1,2, - - -, M$$

$$x_j \le d_j \delta_j \quad ; j = 1,2, - - -, N$$
$$x_j \ge 0 \text{ and } \delta_j = 1 \text{ or } \delta_j = 0$$

And or for all values

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$$\delta_j = 1 \quad \delta_j = 0 \quad ; j = 1,2,---,N$$

From the previous model, we notice that x_j takes a positive value only when $\delta_j = 1$, and in this case, the production of the product j is limited by the quantity d_j and the fixed production cost K_j is included in the goal function

The idea of indeterminacy is the basis of neutrosophic science represented here through the use of the binary integer variable because the optimal solution depends on the decision to produce a product or not to produce it, although we cannot guarantee the company a safe working environment in light of the great changes in the labor market through price strikes, resource availability or non-availability, and so on.

So it was necessary to reformulate this problem using neutrosophic values for the sales opportunity d_j and the cost of producing one unit of each product $C_j$and selling price P_j so that the sales opportunity becomes $d_j + \varepsilon_j$, production cost $C_j + \mu_j$ and selling price $P_j + \varphi_j$ where ε_j and μ_j and φ_j are the indeterminacy and is the change in the sales opportunity, cost and selling price respectively depending on the conditions of the work environment and takes one of the following forms:

$\varepsilon_j = [\lambda_{j1}, \lambda_{j2}]$ Or $\varepsilon_j = \{\lambda_{j1}, \lambda_{j2}\}$ ------- and $\mu_j = [\nu_{j1}, \nu_{j2}]$ او $\mu_j = \{\nu_{j1}, \nu_{j2}\}$ ----------and $\varphi_j = [\theta_{j1}, \theta_{j2}]$ او $\varphi_j = \{\theta_{j1}, \theta_{j2}\}$----------

Which are values close to the values d_j and C_j and can be any neighborhood to them.

Then the text of the problem becomes as follows:

The text of the problem according to neutrosophic science:

A company is planning to produce N product where the product jا needs a fixed preparation cost or a fixed production cost K_j independent of the quantity produced, and needs a variable cost $C_j + \mu_j$ per production unit commensurate with the quantity produced, we suppose that each unit of the product j needs a_{ij} a unit of the supplier i where there is M supplier. Assuming that the product j that has a sales opportunity $d_j + \varepsilon_j$ is sold at the price of $P_j + \varphi_j$ monetary unit per unit and that only b_j unit of the supplier i is available where $i = 1,2,---,M$ the goal of the problem becomes to determine the optimal product mix that makes the net profit as great as possible.

Formulation of the mathematical model:

Determination of the cost:

From the text of the problem, we note that the total cost of production is the fixed cost in addition to the variable cost, which is a nonlinear function of the quantity produced,

But with the help of binary integer variables $\boldsymbol{\delta_j}$, the problem can be formulated in the form of a linear model with integers

We assume that the binary integer variable δ_j symbolizes the decision to produce the product j or not to produce it in other words

$$\delta_j = \begin{cases} 1 & j \text{ if production desicion was taken} \\ 0 & \text{otherwise} \end{cases}$$

Then the cost of producing one unit of the product becomes as follows $K_j\delta_j + (C_j + \mu_j)x_j$, where $\delta_j = 1$ if $x_j > 0$ and $\delta_j = 0$ if $x_j = 0$ and therefore the goal function becomes as follows:

$$Z = \sum_{j=1}^{N} (P_j + \varphi_j)\, x_j - \sum_{j=1}^{N} \left(K_j\delta_j + (C_j + \mu_j)x_j\right)$$

Restrictions of the problem:

A restriction on the supplier i is given in the following relationship:

$$\sum_{j=1}^{N} a_{ij}\, x_j \le b_j \quad ; i = 1,2,---,M$$

The restriction of the demand for the product j is given by the following relationship:

$$x_j \le (d_j + \varepsilon_j)\delta_j \quad ; j = 1,2,---,N$$

Mathematical model: Find the maximum value of the function:

$$Z = \sum_{j=1}^{N} (P_j + \varphi_j)\, x_j - \sum_{j=1}^{N} \left(K_j\delta_j + (C_j + \mu_j)x_j\right)$$

Within Restrictions

$$\sum_{j=1}^{N} a_{ij}\, x_j \le b_j \quad ; i = 1,2,---,M$$

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$$x_j \leq (d_j + \varepsilon_j)\delta_j \quad ; j = 1,2, - - -, N$$

$$x_j \geq 0 \text{ and } \delta_j = 1 \text{ or } \delta_j = 0$$

And or for all values

$$j = 1,2, - - -, N$$

From the previous model, we note that x_j takes a positive value only when $\delta_j = 1$ and in this case the production of the product j is limited by the quantity $d_j + \varepsilon_j$ and the fixed production cost K_j included in the goal function, by solving this model we get an optimal neutrosophic value for the goal function NZ^* through which we know the profit that the company can achieve in the best and worst conditions and enable the company to develop appropriate plans for the workflow in it.

3. Conclusion and Results

In this study, we presented important ideas for building mathematical models for practical problems that require that their solutions be correct values, and through which he showed the importance of using the binary integer variable in obtaining correct values, as it helps in converting some nonlinear mathematical programming problems into linear programming problems, and also the importance of using neutrosophic values to obtain an ideal solution that guarantees the company a safe workflow with the fluctuations of working conditions, we focus on the need to use neutrosophic values in problems that are affected by surrounding conditions, and also the use of binary integer to convert some nonlinear programming problems into linear programming problems, and this is what we will present in later researches .

References

[1] Bukajah J.S., Mualla, W... and others - Operations Research Book translated into Arabic - The Arab Center for Arabization, Translation, Authoring and Publishing -Damascus -1998. . (Arabic version).

[2] Maissam Jdid, Operations Research, Faculty of Informatics Engineering, Al-Sham Private University Publications, 2021, (Arabic version).

[3] Maissam Jdid, Huda E Khalid ,Mysterious Neutrosophic Linear Models, International Journal of Neutrosophic Science, Vol. 18,No. 2, 2022

[4] Florentin Smarandache, Maissam Jdid, On Overview of Neutrosophic and Plithogenic Theories and Applications, Prospects for Applied Mathematics and Data Analysis (PAMDA*)*, Vol .2, No.1, 2023.

[5] Maissam Jdid, A. A. Salam,Using the Inverse Transformation Method to Generate Random Variables that follow the Neutrosophic Uniform Probability Distribution. Journal of Neutrosophic and Fuzzy Systems (JNFS), Vo .6, No. 2, 2023

[6] Mohammed Alshikho, Maissam Jdid, Said Broumi ,Artificial Intelligence and Neutrosophic Machine learning in the Diagnosis and Detection of COVID 19, Journal Prospects for Applied Mathematics and Data Analysis ,Vol 01, No,02 USA,2023

[7] Mohammed Alshikho, Maissam Jdid, Said Broumi,A Study of a Support Vector Machine Algorithm with an Orthogonal Legendre Kernel According to Neutrosophic logic and Inverse Lagrangian Interpolation, Journal of Neutrosophic and Fuzzy Systems(JNFS),Vo .5,No .1, 2023

[8] Maissam Jdid, Khalifa Alshaqsi, Optimal Value of the Service Rate in the Unlimited Model $\mathbf{M}\backslash\boldsymbol{M}\backslash\mathbf{1}$, Journal of Neutrosophic and Fuzzy Systems(JNFS),Vo .6,No .1, 2023

[9] Maissam jdid- Hla Hasan ,The state of Risk and Optimum Decision According to Neutrosophic Rules, International Journal of Neutrosophic Science (IJNS),Vol. 20, No.1,2023

[10] Maissam jdid ,Important Neutrosophic Economic Indicators of the Static Model of Inventory Management without Deficit, Journal of Neutrosophic and Fuzzy Systems(JNFS),Vo .5,No .1, 2023

[11] Maissam Jdid , Huda E. Khalid , Neutrosophic Mathematical formulas of Transportation Problems Neutrosophic sets and Systems, NSS, Vol .51, 2022

[12] Maissam Jdid, AA Salama, Huda E Khalid ,Neutrosophic Handling of the Simplex Direct Algorithm to Define the Optimal Solution in Linear Programming ,International Journal of Neutrosophic Science, Vol. 18,No. 1, 2022

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