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TEACHING LINE MODELS AND SOLUTIONS WITH THEIR PROGRAMMING SYSTEMS

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ABSTRACT

In this work, the solution of a system of linear algebraic equations using the object-oriented programming language C ++ builder 6 and its solution, consisting of Gauss, Kramer, Jordan and simple iteration methods.

Keywords: *C++ builder 6 programming language, mathematical model, optimal solution, exact solution, approximate solution.*

АННОТАЦИЯ

В данной работе решение системы линейных алгебраических уравнений с использованием объектно-ориентированного языка программирования C ++ builder 6 и его решение, состоящее из методов Гаусса, Крамера, Джордана и простых итераций.

Ключевые слова: *Язык программирования C++ builder 6, математическая модель, оптимальное решение, точное решение, приближенное решение.*

INTRODUCTION

It is known that the mathematical model of any object is represented by mathematical relations (equations, inequalities or their systems). One of these relationships is a system of linear algebraic equations. A system of n linear algebraic equations unknown to us be given The numbers given here are s, s are unknown. If (1.1) the main determinant corresponding to the system is different from zero i.e.

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n} = b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n} = b_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn} = b_n \end{cases} \quad \textbf{(1.1)}$$

be given The numbers given here are s, s are unknown. If (1.1) the main determinant corresponding to the system is different from zero.

$$\Delta = \begin{vmatrix} a_{11} & a_{12} \dots a_{1n} \\ a_{21} & a_{22} \dots a_{2n} \\ \dots & \dots \\ a_{n1} & a_{n2} \dots a_{nn} \end{vmatrix} \neq 0$$

DISCUSSION AND RESULTS

Since there are several ways to solve a system of linear algebraic equations, let us consider the stages of building a mathematical model using the Kramer rule, Gaussian, and inverse matrix methods, and methods for using modeling in software development (1.1) for the system.

Method 1: Kramer's rule method in solving a system of linear algebraic equations.

The Kramer rule method is also commonly referred to as the determinants method. We consider this method (1.1) for a system of linear algebraic equations. According to this method, the following (n + 1) units are n-order

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$$\Delta = \begin{vmatrix} a_{11} & a_{12} \dots a_{1n} \\ a_{21} & a_{22} \dots a_{2n} \\ \dots & \dots \\ a_{n1} & a_{n2} \dots a_{nn} \end{vmatrix}, \quad \Delta_{x_1} = \begin{vmatrix} a_{11} & a_{12} \dots a_{1n} \\ a_{21} & a_{22} \dots a_{2n} \\ \dots & \dots \\ a_{n1} & a_{n2} \dots a_{nn} \end{vmatrix}, \quad \Delta_{x_n} = \begin{vmatrix} a_{11} & a_{12} \dots a_{1n} \\ a_{21} & a_{22} \dots a_{2n} \\ \dots & \dots \\ a_{n1} & a_{n2} \dots a_{nn} \end{vmatrix}$$

the values of the determinants are and are unknown. They are found by formula

$$x_1 = \frac{\Delta_{x_1}}{\Delta}, \; x_2 = \frac{\Delta_{x_2}}{\Delta}, \; .., \; x_n = \frac{\Delta_{x_n}}{\Delta}$$

The disadvantage of the Kramer method is the difficulty associated with calculating high-order determinants. Typically, Kramer's rule is used in a system of equations when the number of equations is small.

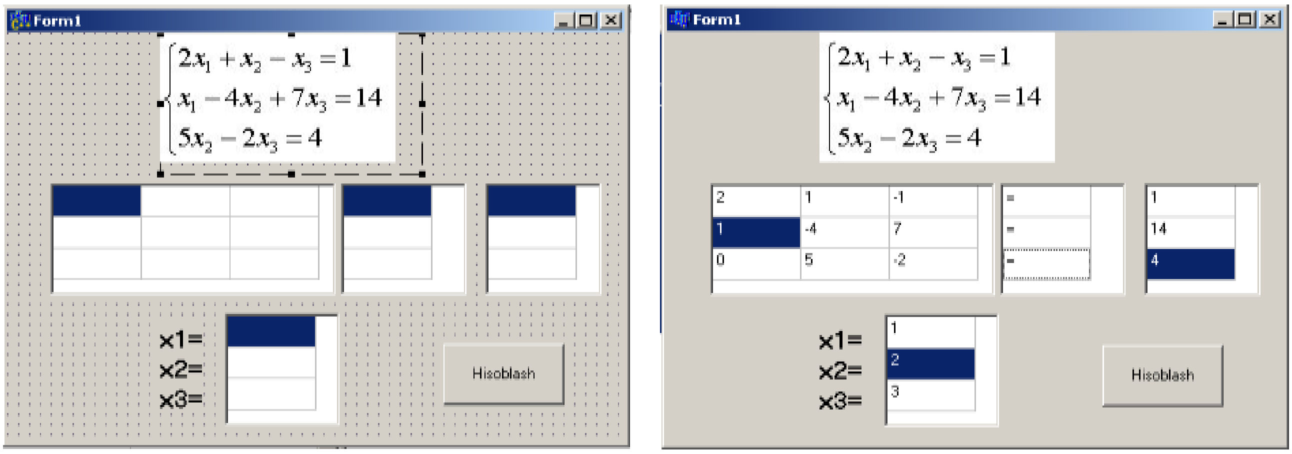
1.1- Assignment:

1.2- Create the following system of linear algebraic equations, a program model in the programming language C ++ Builder 6 using the Kramer rule method.

$$\begin{cases} 2x_1 + x_2 - x_3 = 1 \\ x_1 - 4x_2 + 7x_3 = 14 \\ 5x_2 - 2x_3 = 4 \end{cases}$$

Once the program is running, you will need 4 StringGrids, 3 Labels, 1 Image, and 1 Button component to program a system of algebraic equations in S ++ Builder 6.

Once the required components are installed in the form window, the application view will look like this.



1-Fig. Software view.

Method 2: Gaussian method for solving a system of linear algebraic equations.

The Gaussian method is a method based on the sequential loss of the unknown, the algorithm of which consists of the following sequence of calculations. (1.1) (if any, can be obtained by substituting the equations in the system). (1.1) is the sum of all terms of the first equation in the system.

$$x_1 + c_{12}x_2 + \ldots + c_{1n}x_n = d_1 \qquad 1.2$$

Here

$$c_{1j} = \frac{a_{1j}}{a_{11}}, \; j = 2,3,\ldots n, \; d_1 = \frac{b_1}{a_{11}}.$$

(1.2) by helping this equation from (1.2) sytem x_1 we lose the unknown.

For this (1.2) equation $a_{11}, a_{31}, \ldots, a_{n1}$, multiplying in series (1.1) the second, third, etc. of the system of equations, respectively. Dividing the n-equations by $x_2, x_3, \ldots, x_n$ depending on the unknown

$$\begin{cases} a_{22}^1 x_2 + \ldots + a_{2n}^1 x_n = b_2^1 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ a_{n2}^1 x_2 + \ldots + a_{nn}^1 x_n = b_n^1 \end{cases} \quad \textbf{(1.3)}$$

We have a system of linear algebraic equations. Here :

$a_{ij}^1 = a_{ij} - a_{i1}c_{1j},\ b_i^1 = d_i - a_{i1}d_1,\ i, j = 2,\ldots,n$

Now from (1.3) system x_2 we should lose unknown. For this (1.3) system`s first

equition $a_{22}^1 \neq 0$ (If $a_{22}^1 = 0$ will be = 0, (1.3) equations in the system exchange th place $a_{22}^1 \neq 0$

$$x_2 + c_{23}x_3 + \ldots + c_{2n}x_n = d_2 \quad (1.4)$$

Here

$$c_{2j} = \frac{a_{2j}^1}{a_{22}^1},\ d_2 = \frac{b_2^1}{a_{22}^1},\ j = 3, 4, \ldots, n$$

Repeat once this process $n-1$

$$x_{n-1} + c_{n-1,n}x_n = d_{n-1} \quad (1.5)$$

We will have equality. Here

$$c_{n-1,n} = \frac{a_{n-1,n}^{n-2}}{a_{n-1,n-1}^{n-2}},\ d_{n-1} = \frac{b_{n-1}^{n-2}}{a_{n-1,n-1}^{n-2}}$$

(1.5) from the previous system using the equation x_{n-1} we lose unknown, x_n for find

$$x_n = d_n \quad (2.6)$$

We will have. Here $d_n = \dfrac{b_n^{n-1}}{a_{n,n}^{n-1}}$

So (1.1) system`s $x_n, x_{n-1}, \ldots, x_2, x_1$ unknowns for clarify Гаусс ways (1.2), (1.4), (1.5) ва (1.6) We have the following solution algorithm based on

$$x_n = d_n,$$
$$x_{n-1} = d_{n-1} - c_{n-1,n}x_n,$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$x_2 = d_2 - c_{23}x_3 - \ldots - c_{2n}x_n,$$
$$x_1 = d_1 - c_{12}x_2 - \ldots - c_{1n}x_n.$$

This formula can be summarized in the following view $x_k = d_k - \sum_{j=k+1}^{n} c_{kj}x_j,\ k = n, n-1, \ldots, 1$

2.1- **Task**. Following

$$\begin{cases} x_1 + 2x_2 - x_3 = -1 \\ 2x_1 - 3x_2 + 4x_3 = 13 \\ -3x_1 + x_2 - 2x_3 = -6 \end{cases}$$

Create a system of linear algebraic equations, a program model in the Gaussian method C ++ Builder 6 programming language. Once the program is running, you will need 2 StringGrid, 3 Label, 1 Image, and 1 Button components to program in a S ++ Builder 6 visual environment to solve a system of algebraic equations.

Once the required components are installed in the form window, the application view will look like this.

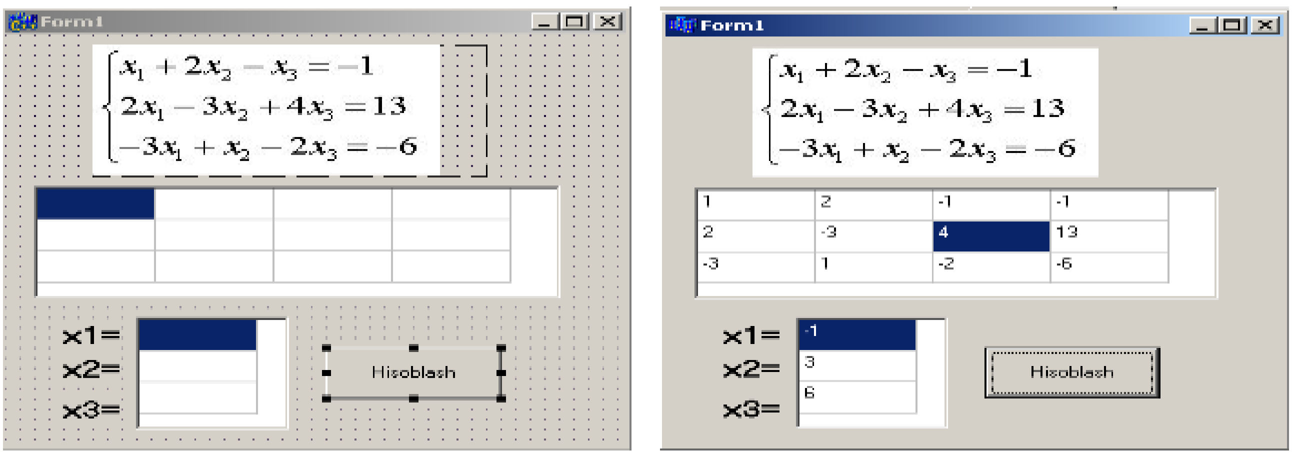


Figure 2. Software view.

Method 3: Inverse matrix method for solving systems of linear algebraic equations.

Let us consider the inverse matrix method in solving a system of linear algebraic equations (1.1). To do this, (1.1) is an n-dimension composed of coefficients in front of the unknowns in the system

$$A = \begin{vmatrix} a_{11} \; a_{12} \dots a_{1n} \\ a_{21} \; a_{22} \dots a_{2n} \\ \dots\dots\dots\dots\dots \\ a_{n1} \; a_{n2} \dots a_{nn} \end{vmatrix}$$

Consider a square matrix. Consider a square matrix.

$A^{-1} * A = E$

would be appropriate. Where E is the unit matrix, namely

$$E = \begin{vmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ & \dots\dots\dots & & \\ 0 & 0 & \dots & 1 \end{vmatrix}$$

Theorem. If the determinant value composed of the elements of the matrix

A is different from zero, i.e., there is an inverse matrix to the matrix A. If there is an inverse matrix to matrix A, it is calculated using the following formula

$$A^{-1} = \frac{1}{\Delta} \begin{vmatrix} a_{11} \; a_{21} \dots a_{n1} \\ a_{12} \; a_{22} \dots a_{n2} \\ \dots\dots\dots\dots\dots \\ a_{1n} \; a_{2n} \dots a_{nn} \end{vmatrix}$$

Here $\Delta = \det A$, $A_{ij} - a_{ij}$ algebraic fillers of elements

$$A_{ij} = (-1)^{i+j} \begin{vmatrix} a_{11} \; a_{21} \dots a_{1j-1} \; a_{1j+1} \dots . \; a_{1n} \\ a_{21} \; a_{21} \dots a_{2j-1} \; a_{1j+1} \dots . \; a_{1n} \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ a_{i-11} \; a_{i-12} \dots a_{i-1j-1} \; a_{i-1j+1} \; a_{i-1n} \end{vmatrix}, \quad i, j = 1, 2, 3, \dots, n.$$

3.1- **Task**. Following

$$\begin{cases} 2x_1 + x_2 + 2x_3 = 4 \\ x_1 - x_2 + 2x_3 = 1 \\ 3x_1 + x_2 - 2x_3 = 3 \end{cases}$$

system of linear algebraic equations, creation of a program model in the programming language C ++ Builder 6 using the inverse matrix method.

Once the program is running, you will need 4 StringGrids, 3 Labels, 1 Image, and 1 Button component to program a system of algebraic equations in S ++ Builder 6. Once the required components are installed in the form window, the application view will look like this.

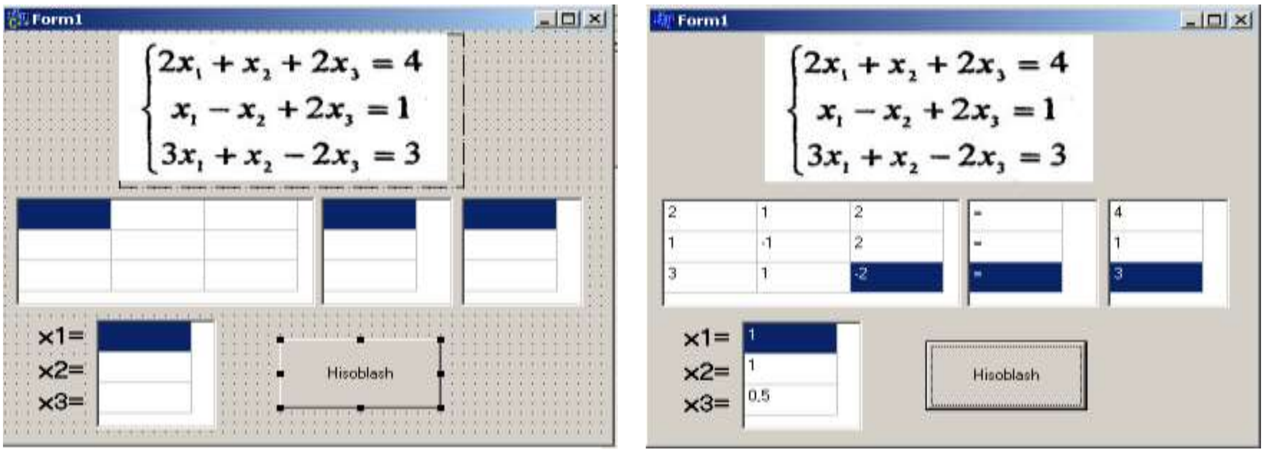


Figure 3. Software view.

(2,3,4) -As can be seen in the figures, in solving a system of linear algebraic equations, the Kramer method, the Gaussian method, the methods of solving inverse matrix methods are mentioned.

CONCLUSION

Denmak can solve any obvious problem in several ways. If the real process in question can be expressed with sufficient accuracy through mathematical relations, it will be possible to solve this problem by constructing a mathematical model. Solving a problem in this way is called the process of mathematical modeling.

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