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USING THE PROGRAM TO SOLVE THE SYSTEM OF LINEAR ALGEBRAIC EQUATIONS BY THE ITERATION METHOD

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Abstract. It is not always possible to find the solution of the system of linear algebraic equations by exact methods. Therefore, numerical methods are used to solve such equations. This work shows the method of finding the solution of the system of linear algebraic equations using the simple iteration method, which is an approximate method of finding the solution. Also, the solutions of the program for the equation worked out in this way are compared.

Keywords: *iteration, algebraic, equations, linear, approx.*

It is not always possible to find the solutions of the system of linear algebraic equations in the teaching of algebra to students. Therefore, approximate calculation methods are used. In this work, iterative methods for solving a system of algebraic equations are considered. The program is shown in the example and the results are shown in the program.

The system of linear algebraic equations can be solved by exact and approximate (iterative) methods. The advantage of solving the system of linear algebraic equations by the iterative method, that is, by the method of successive approximation, is the simplicity of the application of such solving methods to programming. Iterative methods require initial approximation to the desired solution before calculation. The speed of convergence of the iterative process depends on the choice of the initial approximation, and also the iteration method allows to find the solution of the system of linear algebraic equations with a given accuracy.

To use the iterative method

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n = b_2 \\ \qquad \cdots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n = b_n \end{cases}$$

system of equations

$$\bar{x} = G\bar{x} + \bar{f} \qquad (2)$$

iterative process by bringing it into view

$$\bar{x}^{(k+1)} = G\bar{x}^{(k)} + \bar{f}\,, \quad k = 0, 1, 2,$$

performed by recurring formulas. Matrix G and vector are formed as a result of substitution in the system of linear algebraic equations above. || ... || symbol denotes the norm of the matrix. ||G|| of the matrix norm < 1 (3) is a necessary and sufficient condition for the approximation of equality.

Also , $|a_{ii}| > \sum_{i,j=1;i\neq j}^{n} |a_{ij}|, \qquad A = \{a_{ij}\}_1^n$ convergence is guaranteed when the condition is met.

$\| \overline{x}^{*} - \overline{x}^{(k+1)} \| \quad \leq \quad \| G \|^{k+1} \cdot \| \overline{x}^{(0)} \| + \dfrac{\| G \|^{k+1}}{1 - \| G \|} \cdot \| \overline{f} \|$ condition is a condition for evaluating the absolute error of a simple iteration.

Consider the following example:

Using simple iteration and Seidel methods, solve the system of equations with Ɛ=0.001 accuracy:

$$\begin{cases} 8x_1 + x_2 + 9x_3 = 10 \\ x_1 + 2x_2 + 6x_3 = 2 \\ -2x_1 + 5x_2 + 2x_3 = 9 \end{cases}$$

Condition (4) is not fulfilled for the system, therefore, we make it appear in accordance with the given requirements, that is, we make it so that the coefficients of the main diagonal are greater than the sum of the coefficients in front of the remaining variables of the line, for this, we perform the following steps in a row we do: $\begin{cases} 7x_1 - x_2 + 3x_3 = 8 \\ -2x_1 + 5x_2 + 2x_3 = 9 \\ x_1 + 2x_2 + 6x_3 = 2 \end{cases}$

$$\begin{cases} x_1 = \dfrac{1}{7}(8 + x_2 - 3x_3) \\ x_2 = \dfrac{1}{5}(9 + 2x_1 - 2x_3) \\ x_3 = \dfrac{1}{6}(2 - x_1 - 2x_2) \end{cases} \quad => \begin{cases} x_1 = 1{,}143 + 0{,}143x_2 - 0{,}429x_3 \\ x_2 = 1{,}8 + 0{,}4x_1 - 0{,}4x_3 \\ x_3 = 0.333 - 0{,}167x_1 - 0.333x_2 \end{cases}$$

Add the coefficients in front of the unknowns on the right-hand side of each equationz:

0,143+0,429=0.572; 0,4+0,4=0,8; 0,167+0,333=0,5

If it is required to solve one system by simple iteration and Seidel methods, it is preferable to use the Seidel method. Because if the condition (4) is satisfied, the Seidel iteration converges faster than the simple iteration.

Solutions of systems of linear algebraic equations cannot always be found in exact ways. Therefore, approximate calculation methods are used.

We compared the results of the program with the results calculated by the analytical method. We think that this article will be very useful for students and teachers. Because the system of algebraic linear equations was developed both analytically and with the help of software. This article is very useful for using the system of linear equations in the iteration method, that is, in the approximate method.

```python
import sys

limit = int(input("Enter the Total Number of Equations:\t"))
# maximum error limit till which errors are considered,
# or desired accuracy is obtained)
allowed_error = float(input("Enter Allowed Error:\t"))
print("\nEnter the Co-Efficients\n")

matrix = [[0 for j in range(limit+1)] for i in range(limit)]
y = [0 for i in range(limit)]

# Read in matrix of coefficients and constants
for count in range(limit):
    for t in range(limit+1):
        print(f" Matrix[{count+1}][{t+1}] = ", end='')
        matrix[count][t] = float(input())

# Initialize the solution vector
for count in range(limit):
    y[count] = 0

# Perform Gauss-Jordan elimination
while True:
    error = 0
    for count in range(limit):
        temp = matrix[count][limit]
        for t in range(limit):
            if t != count:
                temp -= matrix[count][t] * y[t]
        temp /= matrix[count][count]
        if abs(temp - y[count]) > error:
            error = abs(temp - y[count])
        y[count] = temp
        print(f"\nY[{count+1}]:\t{y[count]}")
    if error < allowed_error:
        break

# Print the solution vector
print("\n\nSolution\n\n")
for count in range(limit):
    print(f" \nY[{count+1}]:\t{y[count]}")
```

```
Y[1]:   -3.732660540254301e+265
Y[2]:   -8.652427335233774e+265
Y[3]:   1.7898407797830132e+266
Y[1]:   -1.905415535565468e+266
Y[2]:   -4.416814571566305e+266
Y[3]:   9.136620893350296e+266
Y[1]:   -9.726596683573294e+266
Y[2]:   -2.254656433826424e+267
Y[3]:   4.66398141620873e+267
Y[1]:   -4.965147039006517e+267
Y[2]:   -1.150937072912293e+268
Y[3]:   2.3808279783800808e+268
Y[1]:   -2.534564341563554e+268
Y[2]:   -5.875201764358465e+268
Y[3]:   1.215344006933261e+269
Y[1]:   -1.2938219857454378e+269
```

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