AMERICAN Journal of Language, Literacy and Learning in STEM Education
Volume 4, Issue 02, 2026 ISSN (E): 2993-2769

Teaching Newtonian and Lagrangian Interpolation Problems Through Software and Methodological Complexes

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Abstract. *This article examines the teaching of Lagrange and Newton methods for interpolation problems through software-methodological complexes. The article examines the block diagram of the problems in Flowgorithm, simple block diagrams, solutions in MathCad and the Python programming language.*

Key words: *Software and methodological complex, Calculation methods, independent learning, MathCad, Python.*

Introduction:

The intensive development of modern information and communication technologies in the world education system has dramatically increased the digital transformation of education systems on a global scale, as well as the strategic importance of the competence of independent knowledge acquisition in the learning process. The COVID-19 pandemic situation has accelerated this trend and forced a revision of traditional paradigms of higher education.

In international practice, the main mechanism for solving this problem is the widely used concept of a software-methodological complex (DMM) - that is, an integrated digital educational environment, which includes electronic educational and methodological resources, interactive exercises, multimedia lectures, diagnostic and monitoring systems. DMM has become not only a source of knowledge, but also an important tool for personalizing education, designing individual learning paths, and pedagogically organizing independent cognitive activity.

Literature review:

The subject of "Computational Methods" is a branch of science that solves problems and examples that do not have an exact solution or are very difficult to solve (series functions, interpolation problems, opaque schemes, etc.) by approximate solutions. The subject of "Computational Methods" is taught in the field of mathematics of higher education institutions 60540100.

In our republic, M.Isroilov, A.Imomov, Sh.M.Imomova, M.Y.Eshnazarova, D.Ashurova and many other scientists and researchers have conducted their scientific research in the field of "Computational Methods".

In the educational process of higher educational institutions, the formation of students' independent mastery of knowledge, skills and competencies is of great importance. The course "Computational Methods" guides students to develop algorithmic thinking, analytical abilities, a scientific worldview, improve motivation for learning, and master the basics of programming. Students who have successfully mastered this subject can work effectively not only in the classroom, but also independently.

Results

In today's era of globalization, the educational process has been reformed, digitized, and widely used electronic educational resources and software. Based on these reforms, we have decided to teach the subject of "Computational Methods" through software and methodological complexes and to improve this process.

Using software and methodological complexes, we have improved the methodological paradigms and technologies for ensuring the seamless integration of theoretical and practical activities in teaching the subject "Computational Methods" in higher educational institutions and for the formation of computational competencies.

Students of higher education institutions can study the subject of "Computational Methods" not only based on theoretical and practical activities, but also solve examples and problems in the mathematical packages MathCAD, Maple, Flowgorithm and Python programming environments. This not only increases students' interest in the subject, but also serves to equally improve their knowledge, skills and qualifications in the programming environment.

Based on a comprehensive examination and analytical assessment of the pedagogical and didactic effectiveness of using software and methodological complexes in the process of teaching the subject "Computational Methods", a set of scientific and methodological concepts and recommendations has been developed aimed at systematically developing the mathematical knowledge, skills and competencies of young specialists and optimizing their intellectual and cognitive potential.

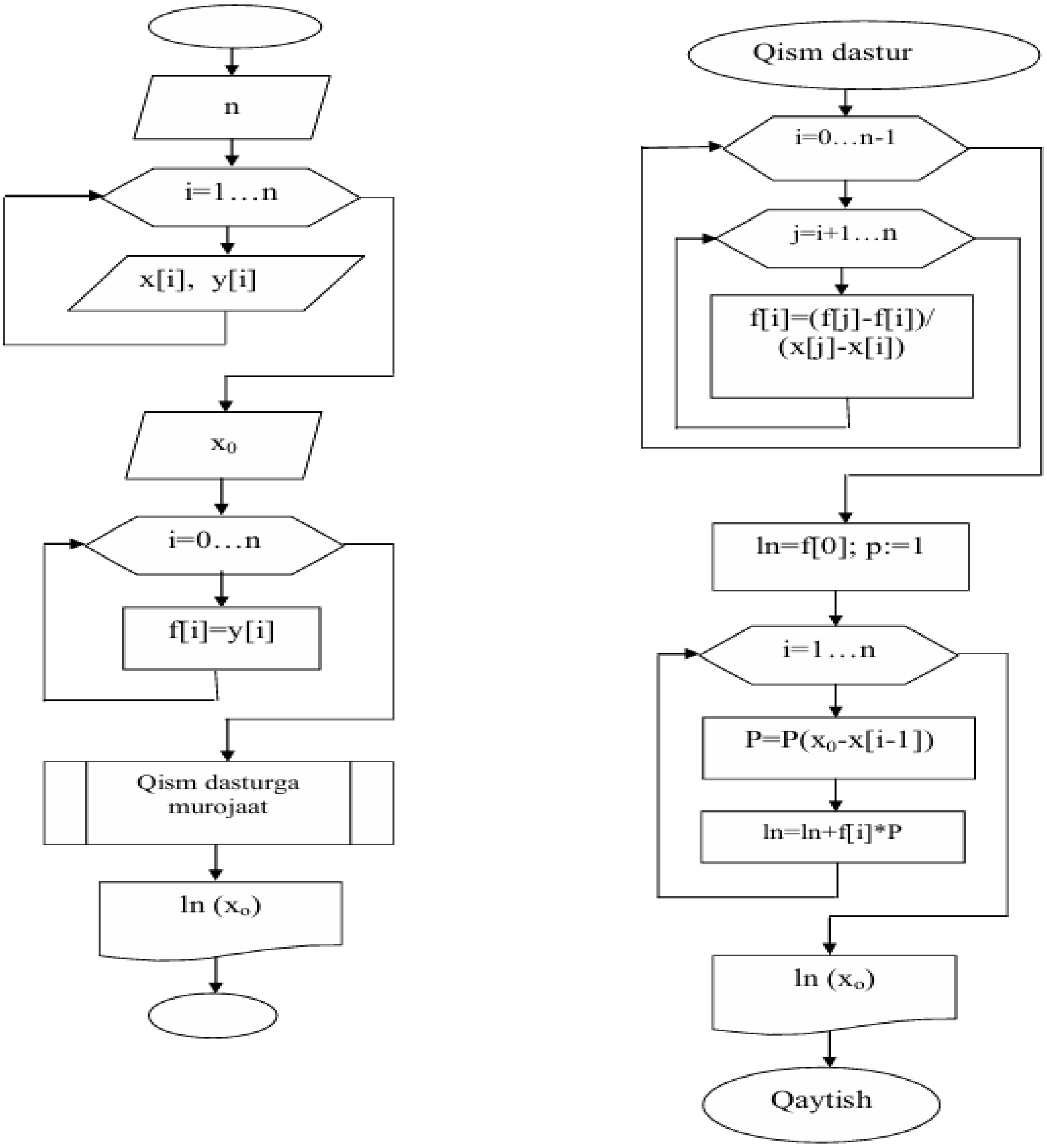
We will consider this process as interpolation problems. Interpolation of functions is one of the important areas of mathematical analysis and computational mathematics, which studies methods for generating continuous functions at given discrete points. In many cases, when studying real processes, experimental results or experimental data are given as a discrete set, and it becomes necessary to build a continuous model based on this data. In such situations, interpolation methods are used.

Interpolation is a process that uses relationships between given data to determine unknown values of a function. This method is widely used in engineering, physics, economics, artificial intelligence, and many other fields. The function resulting from interpolation is viewed as a continuous curve that passes through a set of initial points.

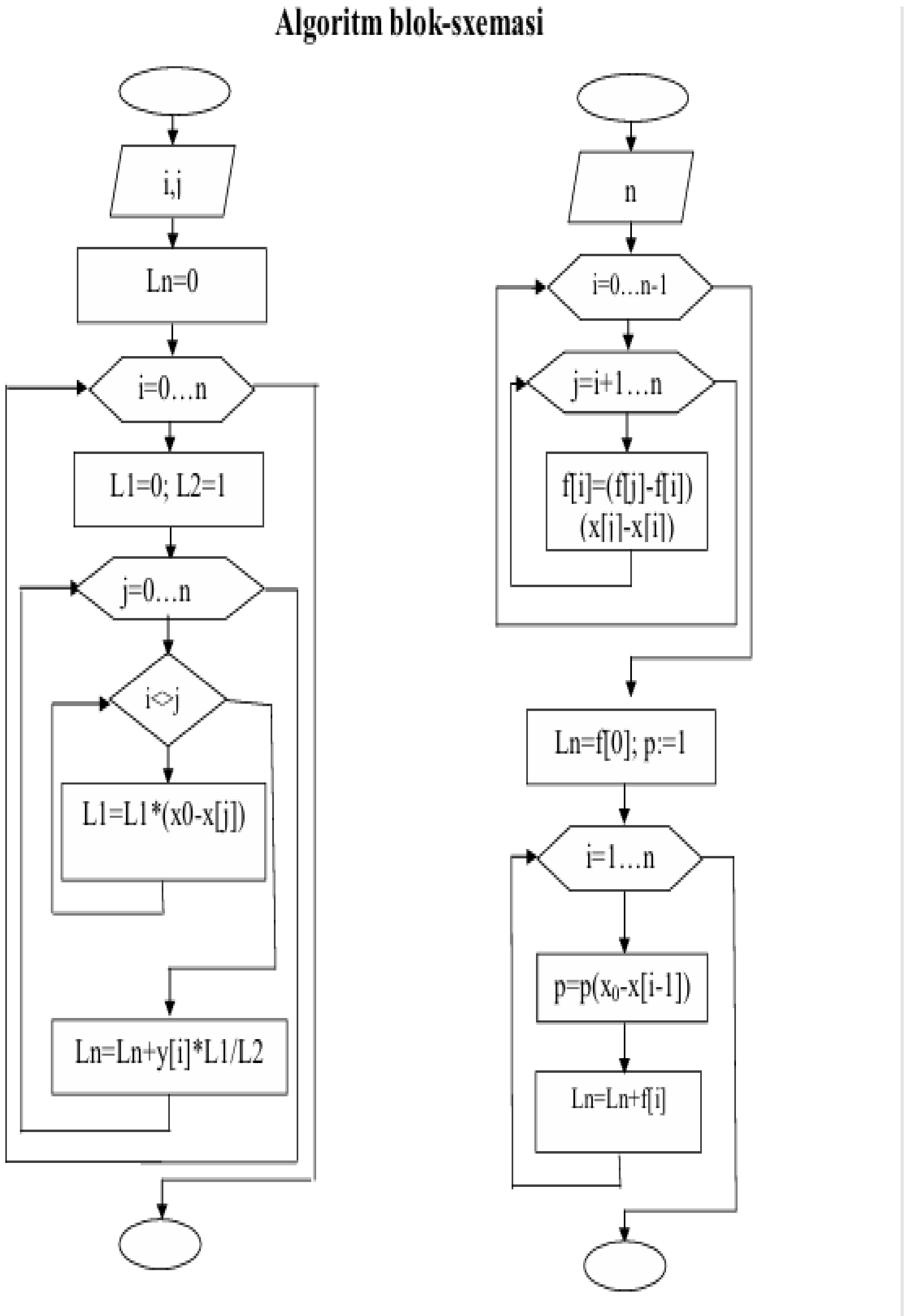
There are various methods for interpolating functions, the most common of which are Newton interpolation, Spline interpolation, and Lagrangian interpolation. Each method has its own advantages, and their choice depends on the characteristics of the problem at hand.

Newton interpolation	Lagrangian interpolation
1. Task: Calculate the differences between given points and create a formula.	1. Function: Create a special "weight" function for each point and combine them all.

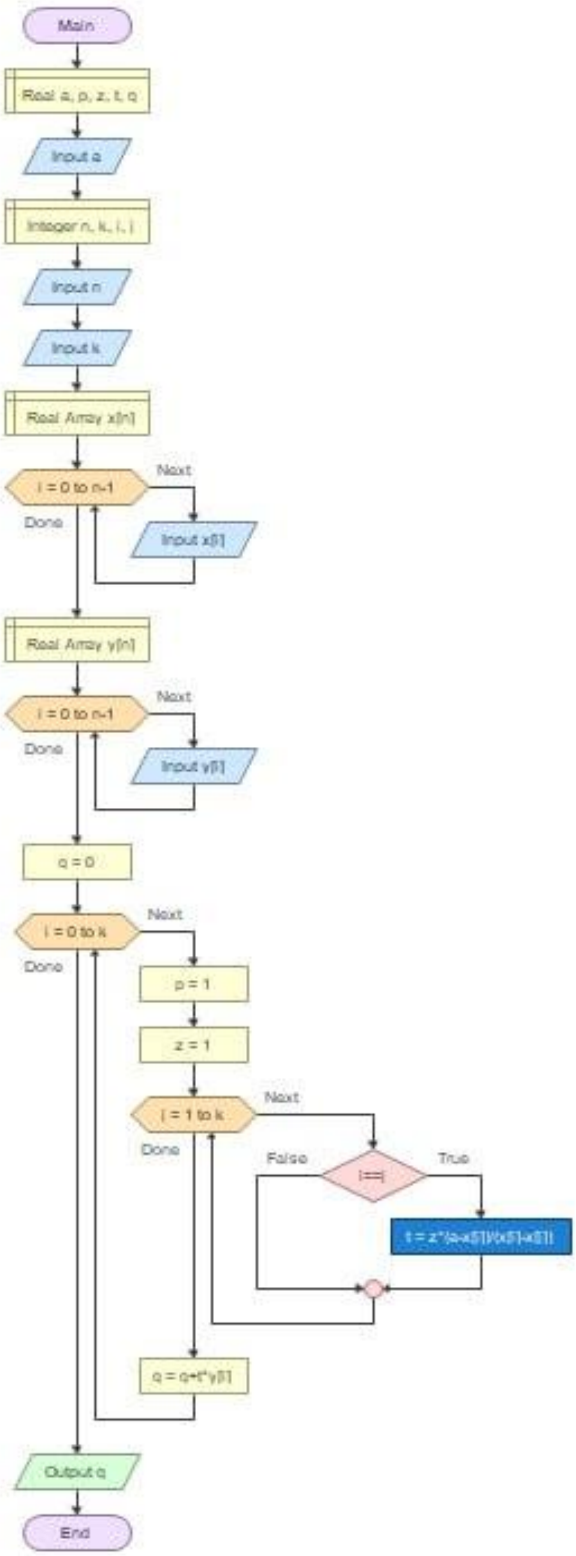
BLOCK DIAGRAM OF NEWTON'S INTERPOLATION PROBLEM



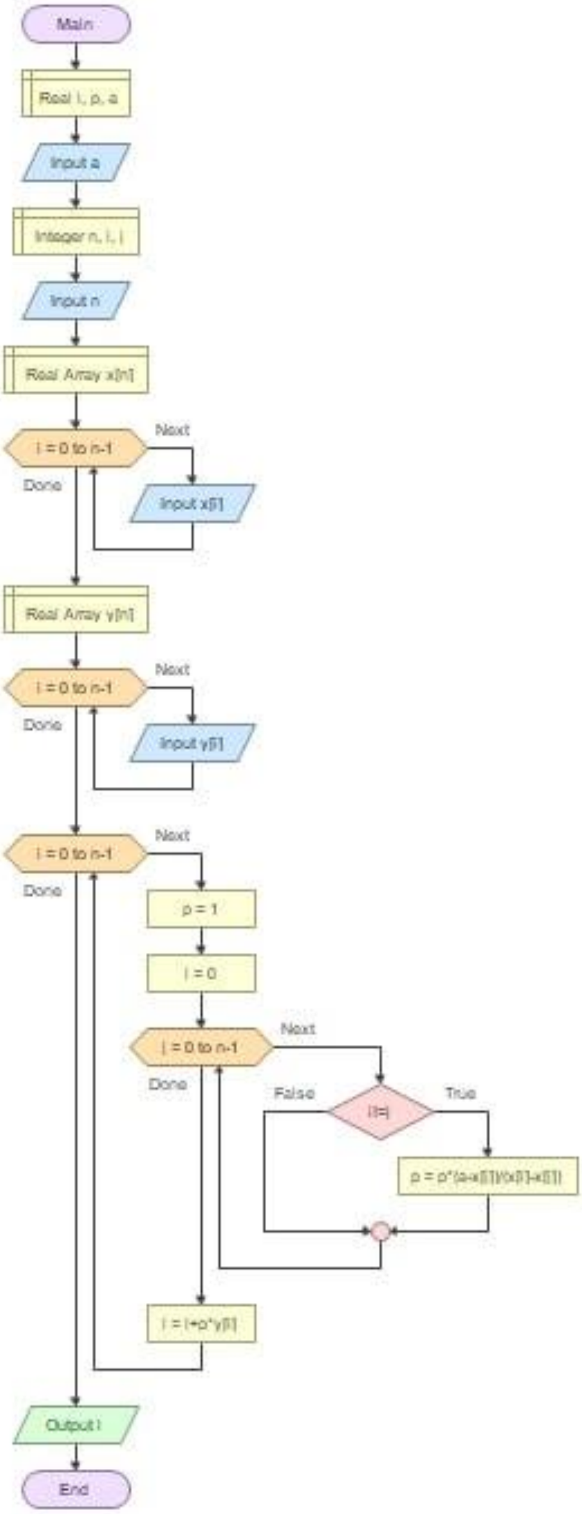
BLOCK DIAGRAM OF THE LAGRANJ INTERPOLATION PROBLEM



BLOCK DIAGRAM OF NEWTON'S INTERPOLATION PROBLEM IN FLOWGORITHM



BLOCK DIAGRAM OF THE LAGRANJ INTERPOLATION PROBLEM IN FLOWGORITHM



STRUCTURE OF INTERPOLATION PROBLEMS IN MATHCAD

Program for constructing Newton interpolation polynomials

In the MathCAD window, we type the following commands:

Nodes, function $n := 4 \quad f(t) := x * \sin(t) \quad a := 0 \quad b := 4 \quad h := (b-a)/n$

Interpolation conditions $i := 0..n \quad x_i := a + ih \quad y_i = f(x_i)$

Values $x := \begin{bmatrix} 0 & 1 & 2 & 3 & 4 \end{bmatrix}^T \quad y = \begin{bmatrix} 0 & 0.8415 & 1.8186 & 0.4234 & -3.0272 \end{bmatrix}^T$

Divided fractions k:=0..n $a_0 := y_0 \quad a_k := \sum_{i=0}^{k} y_i \prod_{j=0}^{k} if\,(i = j, 1, 1/(x_i - x_j))$

$$Nn(t) := a_0 + \sum_{i=1}^{n} a_i \prod_{j=0}^{i-1} (t - x_j)$$

Newton increases

Results $Nn(2.3) = 1.6893 \quad Nn(2) = 1.8186 \quad Nn(3) = 0.4234$

The result shows that the algorithm is working correctly.

Program for constructing a Lagrangian interpolation polynomial

Lagrange interpolation is a multiplication: $L_n(x) = \sum_{i=0}^{n} f(x_i) l_i(x), l_i(x) = \prod_{j=0, j \neq i}^{n} \frac{x - x_j}{x_i - x_j}$.

In the MathCAD window, type the following commands:

Nodes, function $n := 4 \quad f(t) := t * \sin(t) \quad a := 0 \quad b := 4 \quad h := (b-a)/n$

Interpolation conditions $i := 0..n \quad x_i := a + ih \quad y_i = f(x_i)$

Values $x := \begin{bmatrix} 0 & 1 & 2 & 3 & 4 \end{bmatrix}^T \qquad y = \begin{bmatrix} 0 & 0 & . & 8 & 4 & 1 & 5- & 1 \end{bmatrix}^T$

Index change area $i := 0..n \quad j := 0..n$

$$Ln(t) := \sum_{i=0}^{n} y_i \prod_{j=0}^{n} if\,(i = j, 1, (t - x_j)/(x_i - x_j))$$

Lagrange interpolation function (3)

Values $Ln(2.3) = 1.689 \quad f(2.3) = 1.715 \quad Ln(1) = 0.841 \quad Ln(2) = 1.8186$

We will show the correctness of the resulting program.

Conclusion

Newtonian and Lagrange interpolation problems in the subject of "Calculus Methods" have an important place in our daily lives. For example, the Lagrange interpolation problem is used in measuring weather temperature.

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