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# METHODS FOR PLOTTING FUNCTION GRAPHS IN COMPUTERS USING MODERN SOFTWARE AND PROGRAMMING LANGUAGES

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## ABSTRACT

*The article discusses methodological issues and implementation features in MS Office software environments (in particular, MS EXCEL VBA) and Borland Delphi (Pascal) of the algorithm for plotting graphs of functions studied in the course of mathematics. The programs presented in the article, which perform graphing with given coefficients, can be used as a visual aid for users, applicants, etc. in the study of functions, as well as as a demo example in the study of the programming environment MS Office and Borland Delphi (Pascal)*

**KEYWORDS:** *Computer Graphics; Study Of Plotting Functions; Method For Plotting Function Graphics; Competence In The Of Computer Graphics; MS Office, MS Graph, MS Excel, MS VBA; Borland Delphi (Pascal)*

## INTRODUCTION

In modern times, the programming of graphs of functions using computers is widely used in the field of scientific and technical research to improve the clarity and readability of the results. It finds application in various computer spheres of human activity, such as scientific research (visualization of the structure of matter, vector fields, etc.) [1], medicine (computed tomography, ultrasound, coronography), development, etc. Computer graphics are widely used in technical and mathematical problems with a visual presentation of the results of practical calculations [2]. Computer graphics, together with computer animation, are a necessary tool in such areas as the automotive industry, aircraft construction, cinema, advertising, art, architecture, simulation of dynamics, as well as in the creation of computer games, etc. [2]. New areas of application of computer graphics appear, and, accordingly, methodological approaches to solving problems in these areas are needed.

This problem is associated with global informatization and widespread use of computer graphics in the life of society. The need for widespread use of graphic software has become especially tangible in connection with the development of widespread use of computers in the production sector. As a result, any technical task requires a visual result. This situation led to a change in the social order of society: a qualitatively new approach to the study of computer graphics is needed.

Teaching computer graphics - one of the most important areas of using a personal computer - is considered today as an independent scientific direction in the development of information technology. The use of graphics in computer systems not only makes it possible to increase the speed of information transfer and increase the level of understanding. The process of improving computer technology and new information technologies occurs very quickly, and the application of these technologies in the field of human activity lags behind their creation [1]. Computer graphics as a field of scientific research has a pronounced complex-applied nature [5]. The key methodological problem of studying computer graphics is the lack of educational literature for those interested.

The article takes into account the situation that users know the basic algorithmic structures and fundamentals of the programming languages discussed below. Some examples show plotting using scaling factors. In the literature, this method is rare and described in insufficient detail. Algorithms for constructing a graph of a continuous function are given. Working with graphics in programming languages is a rather complicated thing that requires knowledge: about algorithmic constructions, about data types (string variables and their compatibility, loops, standard and custom procedures and functions, method of coordinates), about knowledge of the display device and its modes of operation [4].

The study of this article contributes to the deepening of knowledge not only in computer science, but also in other subjects. Function plotting and scaling is used in many mathematical applications. Plotting a function allows you to understand screen coordinates, graphic primitives and their use, working with strings, numerical methods for solving mathematical problems. After studying the article, users should be able to: scale the (Cartesian) coordinate systems for displaying on the monitor, build graphs of continuous functions and coordinate axes, digitize coordinate axes, build several graphs, illustrate mathematical problems for plotting functions [4].

**Materials/ methods/ results**. The process of creating graphs of functions in MS Office packages is not complicated, however, this function differs with several limitations compared to each other. For example, Microsoft Word and Microsoft Excel. If the function graphs are not very complex, the capabilities of Word will be enough.

The first method for creating graphs of functions in MS Office packages is building using an object (special module) - Microsoft Graph. Function graphs (or charts) are a graphical way of displaying some numerical data. Therefore, the plotting of the graphics is carried out simultaneously with the creation of the table of values or after that. The rows of the table of values display sets of numbers that will be located on the vertical axis (value axis) of the chart. Having built a diagram, we can change its type by choosing the type "graph"

The second method for creating function graphs in MS Office packages is to graph functions using VBA in MS Office package. Let's take a closer look at this method. [6]

When solving scientific and technical problems, it is often necessary to display the results in graphical form. In such cases, the MS Excel Chart Wizard is used to solve problems. In this case, the user program must display the data for the graph (diagram) on the worksheet and call the appropriate methods necessary for the graphical display of the results of the program's work. Methods for plotting charts can be obtained using the Chart Wizard in macro recording mode.

**Example No 1**. Plot the function y = 2x4 + 2x3-2x-2 on the segment [-4,4].

Solution: Using for we tabulate the given function on the segment [-4,4] with a step of 0.1 and display the results in the first and second columns of the worksheet Sheet1. In order to write the part of the program that is responsible for the diagram, you need to go to Sheet1 and record the macro, that is, write the program code automatically.

The result of the program will be a graph drawn on the sheet "Sheet1". If the last line issued by the chart wizard is deleted, the chart will be displayed not on the worksheet, but in a separate blank sheet. Program source code:

```
Sub Graph1()
Dim x As Double, n As Long
Sheets(«Sheet1»).Select
n = 0 '
For x = -4 To 4 Step 0.1
  n=n+1
  Cells(n, 1) = x
  Cells(n, 2) = x ^ 4 + x ^ 3 – 2 * x – 2
Next x
Charts.Add
ActiveChart.ChartType = xlXYScatterLinesNoMarkers
ActiveChart.SetSourceData Source:=Sheets(“Sheet1”).Range(“A1:B”+ Trim(Str(n)))
ActiveChart.Location Where:=xlLocationAsObject, Name:=”Sheet1”
End Sub
```

**Example No. 2**. The program for automatic construction of the graph of this function and the tangent to it at x0 = 0.1.

$$y = x + \frac{x^3}{3!} + \frac{x^5}{5!} + \ldots$$

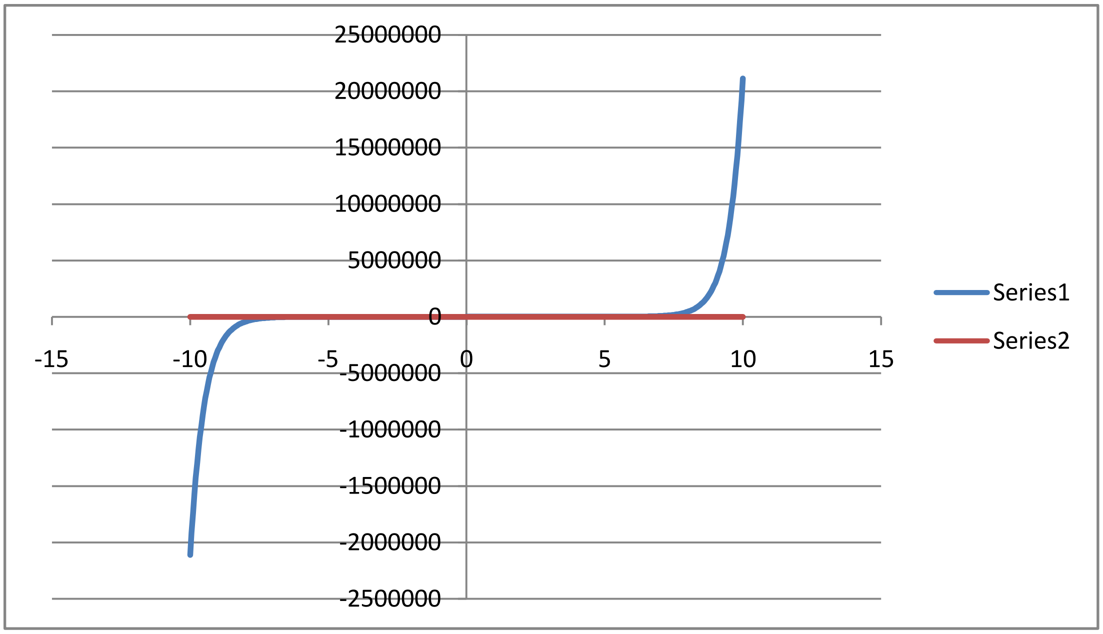
To calculate the value of a function at an arbitrary point, we use the function F1 (x) with a real argument x. Using the variable a, we calculate the value of the next term. The variable z is responsible for the sign of the terms. The variable n is equal to the power of x. Then the integer part of the number n \ 2 + 1 will be equal to the number of the next term. Change the z sign when the integer [n / 2] is even (through two terms).

```
Function F1(x As Double) As Double
Dim S As Double, a As Double, n As Long, z As Long
a = x: S = a: n = 1: z = 1
While Abs(a) > 0.000000001
    n = n + 2
    a = a * x * x / ((n – 1) * n): S = S + z * a
     If (n \ 2 Mod 2) = 0
         Then z = -z
Wend
F1 = S
End Function
Function F2 (x As Double) As Double
    Dim d As Double: d = 0.0000001
    F2 = (F1(x + d) – F1(x)) / d
End Function
Function F3(x As Double, x0 As Double) As Double
F3 = F1(x0) + F2(x0) * (x – x0)
End Function
Sub Graph2(a As Double, b As Double, h As Double, x0 As Double)
Dim x As Double, n As Long
    n = 0
For x = a To b + 0.001 * h Step h
    n = n + 1
    Cells(n, 1) = x
    Cells(n, 2) = F1(x)
    Cells(n, 3) = F3(x, x0)
Next x
```

```
    Charts.Add
    Active Chart. Chart Type = xlXYScatterLinesNoMarkers
Active Chart. Set Source Data Source:=Sheets("Sheet1").Range("A1:C"+ Trim(Str(n)))
    Active Chart. Location Where:=xlLocationAsObject, Name:="Sheet2"
End Sub
Sub graph1()
    Dim a As Double, b As Double, h As Double, x0 As Double
    Sheets("Sheet1").Select
    a = -10: b = 10: h = 0.05: x0 = 0.1
    Call Graph2(a, b, h, x0)
End Sub
```

The result of the program execution:

| | A | B | C |
|---|---|---|---|
| 4 | -9,85 | -1,6E+07 | -13,9434 |
| 5 | -9,8 | -1,4E+07 | -13,8733 |
| 6 | -9,75 | -1,3E+07 | -13,8032 |
| 7 | -9,7 | -1,2E+07 | -13,7331 |
| 8 | -9,65 | -1,1E+07 | -13,663 |
| 9 | -9,6 | -9656937 | -13,5929 |
| 10 | -9,55 | -8758848 | -13,5228 |
| 11 | -9,5 | -7944677 | -13,4527 |
| 12 | -9,45 | -7206566 | -13,3826 |
| 13 | -9,4 | -6537392 | -13,3126 |
| 14 | -9,35 | -5930701 | -13,2425 |
| 15 | -9,3 | -5380639 | -13,1724 |
| 16 | -9,25 | -4881902 | -13,1023 |
| 17 | -9,2 | -4429684 | -13,0322 |
| 18 | -9,15 | -4019626 | -12,9621 |
| 19 | -9,1 | -3647780 | -12,892 |
| 20 | -9,05 | -3310567 | -12,8219 |
| 21 | -9 | -3004744 | -12,7518 |
| 22 | -8,95 | -2727372 | -12,6818 |
| 23 | -8,9 | -2475787 | -12,6117 |
| 24 | -8,85 | -2247578 | -12,5416 |




All the given program blocks must be placed in any order in one module. The developed program is quite versatile. To plot another function, you just need to replace the body of the F1 function. In the English version of MS Office, you need to replace the sheet name [6].

Now let's look at plotting functions using Borland Delphi (Pascal). Graphs of functions on a computer using Borland Delphi (Pascal) can be built in text or graphic video mode. Memory management in these modes is carried out using constants, procedures and functions of the standard CRT and GRAPH modules.

In text mode, depending on the type of video adapter installed in the computer, the screen sizes can be 80 * 25, 80 * 43, 80 * 50 or 40 * 25, 40 * 43, 40 * 50 (in the graphic mode, the screen sizes are from 320 * 200, 640 * 480, 1280 * 1024). The function graph should look good on the computer screen and be accompanied by explanatory information that would facilitate its analysis. When displaying a graph on the screen, there is a problem with the choice of scaling; the need to evaluate the boundaries of changing the argument and function: the relationship between real and integer values of position numbers on the screen, X and Y.

Using Borland Delphi (Pascal), plot a continuous function. The first method is to build a graph, define several of its points and connect them sequentially with a continuous line. In this method, there are some difficulties when building a graph on a computer, which origin is the upper left corner. Therefore, we place the graph of the function in the center of the screen, aligning the center of the graph with the center of the screen. On the computer screen, you can arrange the function graph to fill the entire screen, half the screen, one third of the screen, a quarter, etc. either in a rectangle or on a grid.

Let us construct an algorithm for the graph of a continuous function f (x) on the segment [x0, y0] for which the values of the minimum ymin and maximum ymax on this segment are known. Let's put in a one-to-one correspondence the point of the coordinate plane on which the graph and screen points are located. To plot the graph, we calculate the value of the function at all points twice: to find ymax and ymin and when plotting the graph.

Therefore, it is more convenient to separate the algorithm for calculating the maximum and minimum values of the graph of the function f (x) into a procedure.

```
Procedure min_max(a,b:integer;327ary min,ymax:real);
    var x:real;
    begin
    x:=x0;
    ymin:=f(x0);
    ymax:=f(x0);
    while x<=y0 do
        begin
        if f(x)<ymin then ymin:=(f(x));
        if f(x)>ymax then ymax:=(f(x));
        x:=x+0.01;
        end; end;
```

If you need to build a graph based on the values already available, for example, obtained during the experiment, then the values of the function points are better to remember in the array. If you are interested in this algorithm, you can implement it yourself.

Scaling the graph allows you to simultaneously plot several graphs of functions in any part of the screen and display accompanying information. To do this, the screen is split into several parts. The cases of dividing the screen into four and six parts and the calculation of the screen scaling factors are proposed to be solved by those of interest independently [5].

To display the coordinate axes and digitize them, that is, to give the graph of functions a familiar look, it is necessary to draw the coordinate axes on the screen. If the graph passes through the origin, then the coordinate axes can be positioned in the center of the screen - the screen center points are (GetMaxX div 2, GetMaxY div 2). Below is a fragment of the program for plotting the coordinate axes in the center of the screen.

The background on which the graph of the function is built is set using the standard procedure setbkcolor (color). The color of the axes is set by setcolor (color). You can put text information on the screen using the special procedure OutTextxy (x, y, 'text'), which outputs the text (string) from a variable to the graphic screen.

In order to apply divisions and numeric marks on the coordinate axis, you need to display not text on the screen, but the value of a real number. To do this, we use the standard procedure str (x: 1, r) to get the representation of a number as a string of characters. We put the result into a character string.

If the graph of a function lies far from the origin, then it is more convenient to plot it on a coordinate grid. For this, the screen is divided by equidistant vertical and horizontal lines. The distances between the grid cells are determined as follows:

dx=(GetMaxX – p)/k, dy=(GetMaxY– q)/k,

where p and q are offsets from the edge of the screen, k is the number of cells.

The algorithm for plotting the graph, marking the grid, digitizing the axes is similar to the algorithm for plotting the full screen plot. If, when solving a problem, it is necessary to know about the presence of the roots of the equation, then the coordinate axis and the grid can be displayed simultaneously on the screen. The determination of the roots of the equation can be separated either into a separate procedure or into a separate module, which can be used in solving other problems. The problem of the size of the grid cells must be considered separately.

## DISCUSSION

Considered are methodological issues and implementation features in MS Office software environments (in particular, ms excel vba) and Borland Delphi (Pascal) of the algorithm for plotting the graphs of functions studied in the course of mathematics. The programs presented in the article, which perform graphing with given coefficients, can be used as a visual aid for users, applicants, etc. in the study of functions, as well as as a demo example in the study of the programming environment MS Office and Borland Delphi (Pascal). In the article, examples showed the construction of graphs using scaling factors. Algorithms for constructing a graph of a continuous function are given.

In the process of creating graphs of functions in MS Office packages, as the first method, a graph of functions was created using an object (special module) - Microsoft Graph. Function graphs (or charts) are a graphical way of displaying some numerical data. Therefore, the plotting of the graphics is carried out simultaneously with the creation of the table of values or after that. As a second method, we created a graph of functions using MS VBA.

In the examples considered, we did not stop at the questions of introducing parameters ourselves without referring to the program code. This requires a window for entering parameters of the Inputbox () type.

Function graphs on computers are a visual representation, a convenient demonstration of material related to the solution of complex technical, mathematical and physical problems.

To display the graphs of functions in the software environment, programming tools (MS VBA) and software without programming tools were used. The results are shown each in separate examples. Both technologies used for charting becomes an efficient and fun process.

## CONCLUSION/RECOMMENDATIONS

When solving problems of programming function graphs, various forms of work were used: discussion, independent work, knowledge testing on individual tasks, writing finished products and submitting them to reviews and conferences.

In this article, a ready-made template for plotting a function graph was offered to familiarize users. They demonstrated the results of the algorithms and explained the implementation of the algorithm for constructing the graph of functions using simple examples. To analyze the operation of the algorithm, problems were considered for plotting trigonometric functions, such as sin (x) and cos (x). Analyzed the results of the program.

The construction of graphs of functions on a computer gives a more visual representation and therefore it is convenient to demonstrate them when explaining complex material, to solve complex technical, mathematical and physical problems. With a visual representation of the graph, scaling factors are introduced and it was suggested to manually calculate them to split the screen into any number of parts. Conducted the construction and digitization of the coordinate axes.

As a result, we can conclude that the software environments used are diverse when plotting functions. Some use software during the build process, some without software. The result depends on the accuracy of the calculation. Both technologies used in charting become an efficient and fun process.

**REFERENCES**

**1.** Sh.Q. Shoyqulov, A. M. Shukurov. Propagation of non-stationary waves of transverse displacement from a spherical cavity in an elastic half-space // International Journal of Advanced Research in Science, Engineering and Technology Vol. 7, Issue 4 , April 2020. p. 13291 –13299)

**2.** Kudratova H. Sh., Shoykulov Sh. K. Information and communication technology in the educational process of preschool educational organization // International Engineering Journal For Research & Development Vol. 5, Issue 5 , 22-08- 2020. p. 1 –5)

**3.** Sh. Q. Shoyqulov. Kompyuter grafikasi : o'quv uslubiy qo'llanma. Qarshi.: Qarshi DU, 2016. (Shoykulov Sh.K. Computer graphics: study guide. Karshi. : Karshi SU, 2016.)

**4.** Andreyeva Ye.V., Bosova L.L., Falina I.N. Matematicheskiye osnovi informatiki. Elektivniy kurs: uchebnoye posobiye. – M.: BINOM. Laboratorii ya znaniy, 2005 – 328 s. (Andreeva Ye.V., Bosova L.L., Falina I.N. Mathematical Foundations of Informatics. Elective course: study guide. – M.: BINOM. Knowledge laboratories, 2005 – 328 p.)

**5.** V.K.Yegerev, B.A.Radunskiy, D.A.Talskiy. Metodika postroyeniya grafikov funksiy.- M.: «Visshaya shkola», 1970. (V.K.Yegerev, B.A.Radunskiy, D.A.Talskiy. Function graphing technique.- M. : «Visshaya shkola», 1970)

**6.** Shmidt V. Visual Basic 5.0. –M. : ABF, 1997. –688s. (Shmidt V. Visual Basic 5.0. –M. : ABF, 1997. –688p.)