

NUMERICAL METHODS SOFTWARE APPLICATION FOR ELECTROTECHNICAL ENGINEERS

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Article presents original way of solving different engineering problems with numerical methods in electro and aeronautical engineering. MATH as a software application for numerical methods for engineers is an application designed to calculate many numerical methods with graphical representation. It is also capable to show every step in the process of calculation and visualize it. The article presents this particular application, available methods and future possibilities.

K e y w o r d s: numerical methods, math

1 INTRODUCTION

Numerical analysis is a subject of extreme interest to mathematicians, computer scientists and engineers who will welcome this application. Presented app connects ability to solve numerical problems and visualize it with a few simple steps. The app is designed mainly for educational purposes for students of electrotechnical and aeronautical engineering universities. To achieve this goal, application was designed to show not only results, but also partial results and solutions, which are important to understand how these methods work and realize all important steps. For engineers, often there is a question which method will be the best to use, the most accurate, the fastest etc. To be able to decide, there is important to know the basis and core of chosen methods. This application is designed to help engineering students to better understand how it works and to learn faster and more easily. Highly regarded by experts in mathematics and engineering, this is application with unlimited applications for undergraduate and graduate students of mathematics, science and engineering. Also professionals and researchers could find it a valuable tool they will turn to again and again.

2 PROGRAMING BACKGROUNG

This program uses Qt version 4.8.1. Qt is a C++ toolkit for cross – platform application development. Qt provides single – source portability across MS Windows, Mac OS X, Linux, and all major commercial Unix variants. Qt is also available for embedded devices as Qt for Embedded Linux and Qt for Windows CE. Qt is available under three different licensing options. The application as itself and programming language which is used are both free and available for download and usage. All this opens many new ways to expand options of applications by authors or with contribution of students as a part of education process or any other who wants to contribute. Mentioned programming background allows making it Windows or Linux compatible what will leads to even greater options of expansion and usage on any university without any additional costs.

3 SUPPORTING METHODS

For purposes of MATH application, it has been divided into two parts. First is main window for numerical calculations and second part is a graph dialog window for plotting graphs as needed or required for visualization functions, function approximation results etc.

In current version of MATH application is possible to choose from methods (**Fig. 1**):

- 1) Nonlinear equations - Bisection method
 - Regula Falsi method
 - Secant method
 - Newton's method
 - Iteration method
- 2) Definite integration - Rectangular method
 - Trapezoid method
 - Simpson's method
 - Monte Carlo hit or miss method
 - Monte Carlo average method
- 3) Double definite integration - Monte Carlo average method
- 4) Numerical derivative – max. 4. degree differentiation
- 5) System of linear equations – Jacobi's iteration method
- 6) Matrix calculation – basic numerical operations, transpose, inverse, etc
- 7) Least square approximation

MATH has a set of built-in functions which contain all of the most common used functions like sine, cosine, tangent, their inverse functions, hyperbolic functions and logarithmic functions as well and a lot of others even less common functions.

MATH has also an option to save and load matrices as it can be required in case of preparations for educational process or for saving data from class.

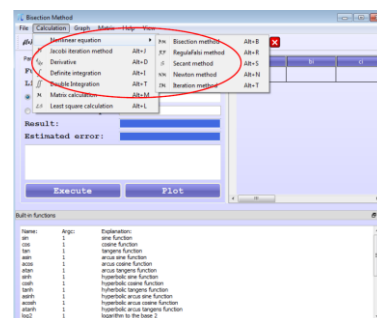


Fig. 1 Supported methods

4 MAIN AND GRAPH DIALOG WINDOW

Graph dialog window is used for visualization functions and plotting graphs as required for showing the results of approximation or derivation of function etc. Next figure (Fig. 2) shows an example of using such graph dialog for approximation of a function using the least square method.

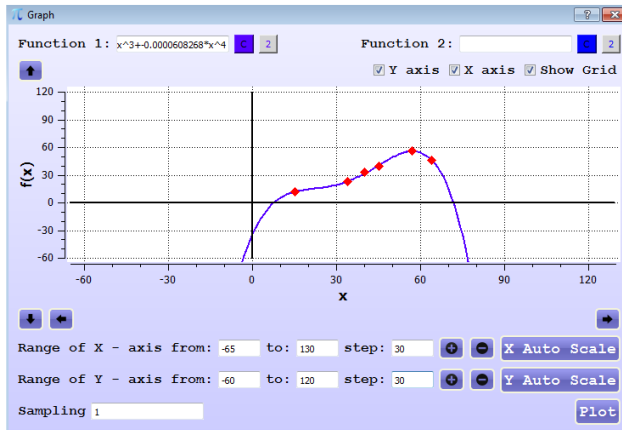


Fig. 2 Least square function approximation

Main window can have various forms. Each form is displayed in the same main window, but appears different depending on what method was chosen. Figure shown below (Fig. 3) displays main window respected to graphical representation of the least square approximation method and used graph dialog window above.

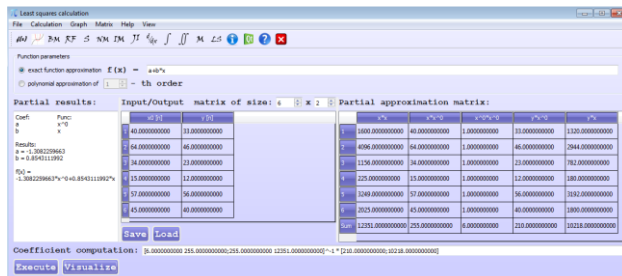


Fig. 3 Main window for Least square method

5 MATH IN REAL LIFE PROBLEMS

If it is using nonlinear equations for calibrating electrical devices, using simultaneous linear equations for calculating aircraft velocity and matrix calculation for determining position of objects through time and their transformation to other coordinate systems or using derivative to measure how system changes with time and tell the character of change, as an engineer everybody will in some point meet with numerical mathematic methods used for various reasons. Therefore the importance of understanding how it works and to choose the best method to find desired solution raises. MATH is supposed to help understand solutions of such problems on deeper level for all engineering students or in praxis.

6 ADVANTAGES OF USING MATH

As very often there is required for engineering students to use, understand and solve nonlinear equations for calibrating electrical devices, there was chosen an example of using Regula Falsi method to prove a point. To understand how it works and do a step by step procedure is important to first plot desired functions (Fig. 4) to know how to proceed next.

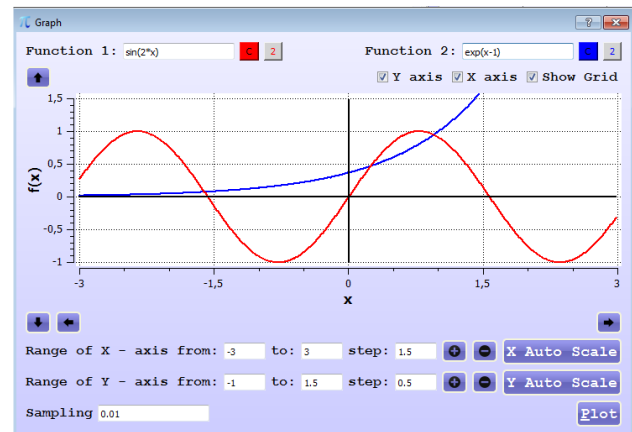


Fig. 4 Regula Falsi method graph dialog window

After we got a graphical representation of a problem, we can proceed to next step, to fill in required parameters in main window for chosen method, in this particular case for Regula Falsi method window (Fig. 5).

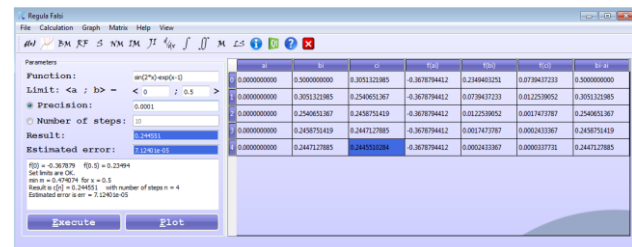


Fig. 5 Regula Falsi method main window

Right after filling in all required parameters we got the result. The advantage of such application is that we don't have only a solution, but also estimated error and we can see every particular step made throughout the process of calculation. So what the student sees is not only a result, but if he made a mistake somewhere he can see it right there and fix it right away.

There is possibility of solving the same problem with more than one method and the user can immediately see what method is faster, more accurate, or what is the reason of miscalculation and which methods are not suitable for solving such problems.

7 CONCLUSION

MATH is a software application designed to calculate roots of nonlinear equation, roots of system of linear equations, differentiate, integrate, approximate, matrix calculation using numerical methods for calculating results, estimated errors and much more. MATH is also capable of drawing standard functions using graph dialog window to help with visualization functions, results, or approximation with given points and much more. There is still a lot of space to extend this app with other methods, so basically this application offers unlimited options also to the future development with main focus in engineering university students' education. This application is also already uploaded on well-known website <http://sourceforge.net/projects/nummath/> for publishing open source software where it was already downloaded by many foreign users. To achieve the main goal for spreading this application to other universities there were created website <https://sites.google.com/site/mathnumapp/> designed for such purpose with manuals and solved examples open to anybody who wants to use it or contribute in any possible way.

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