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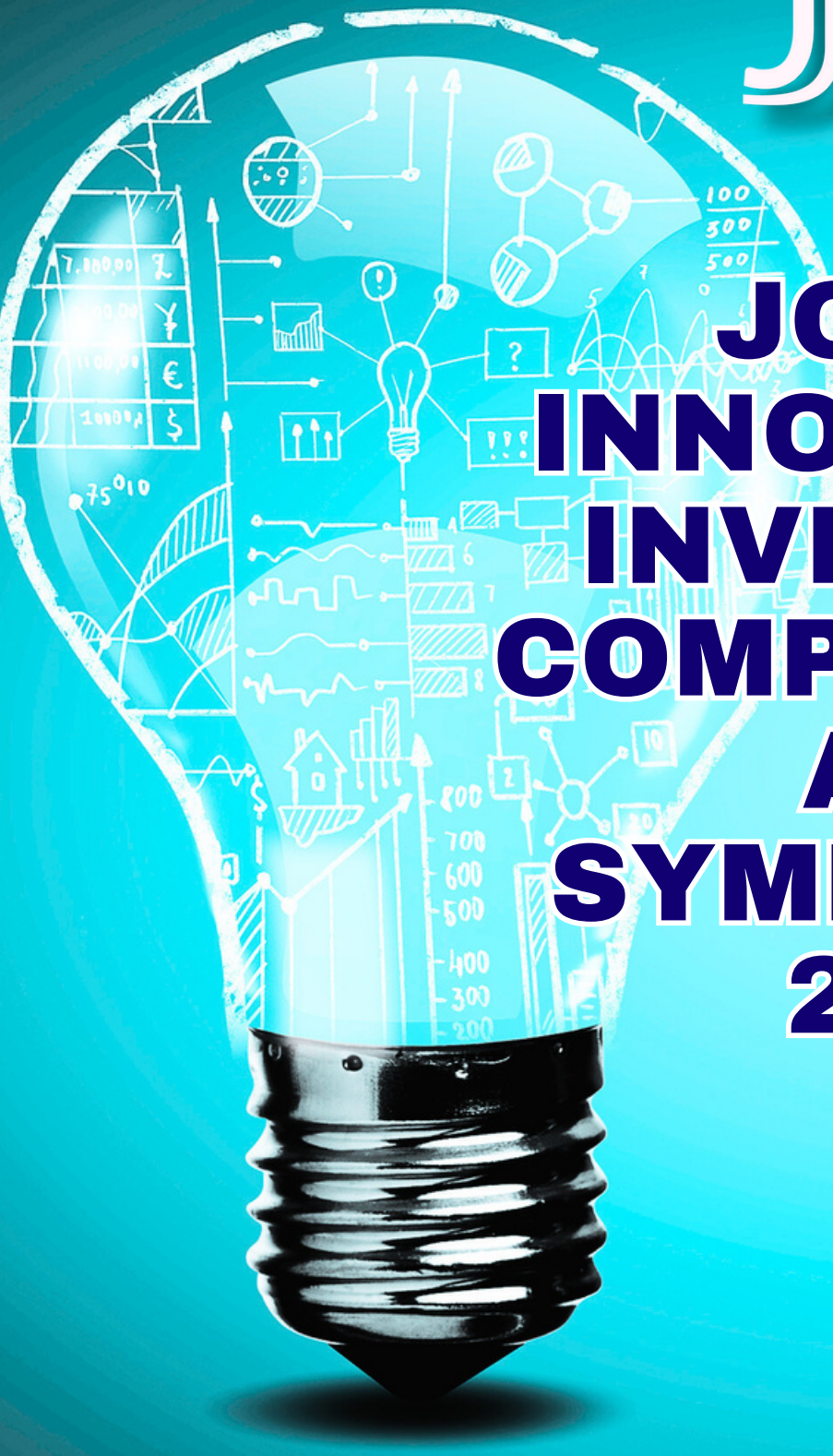

JOHOR INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2023

" Innovation Inspires a Society to be Critical and Creative"

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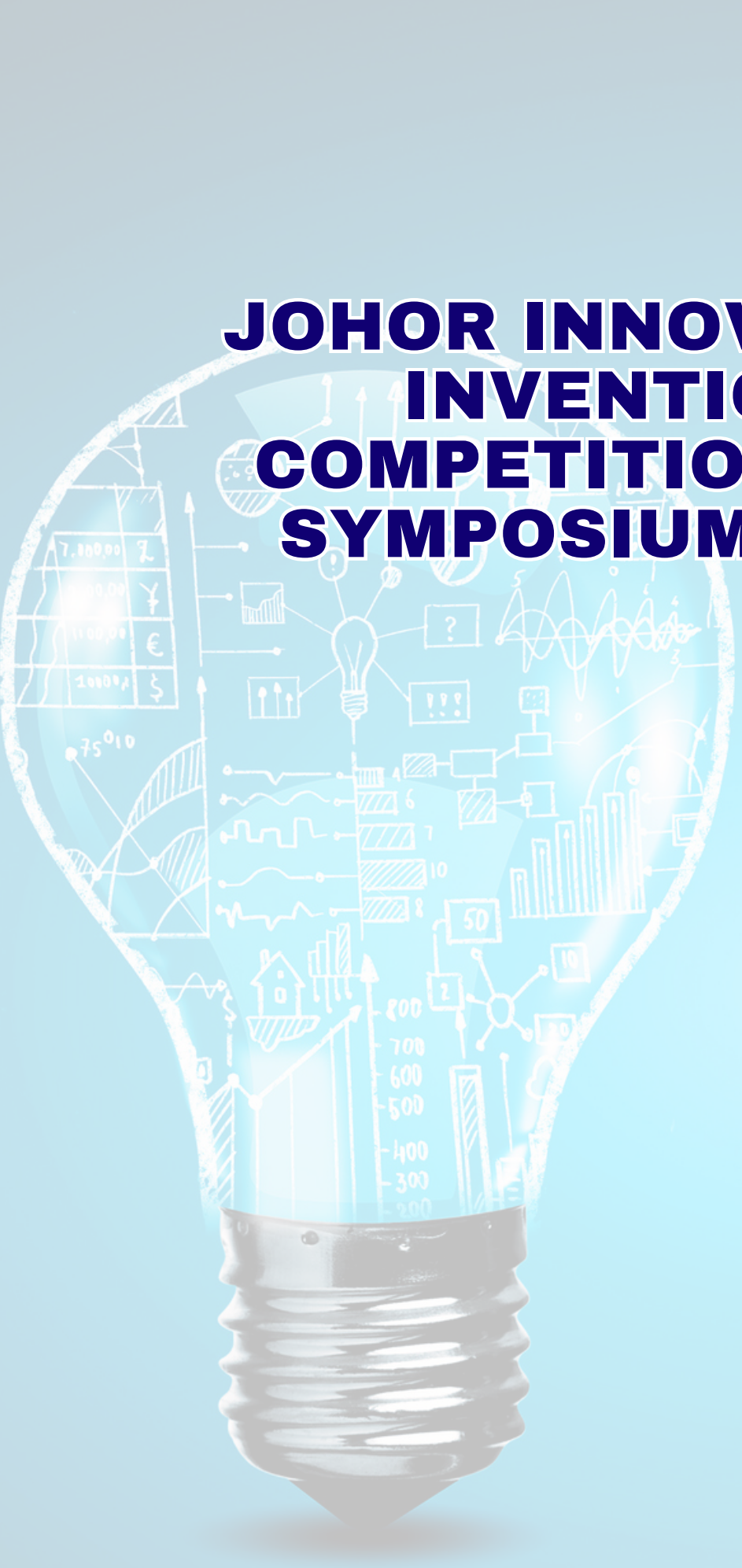

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" Innovation Inspires a Society to be Critical and Creative"

Editors-in-Chief

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor Innovation Invention Competition and Symposium 2023 (JIICaS2023), where JIICaS2023 is a virtual platform for all creative minds to share and present their invention and innovation. The extended abstracts are divided into two categories, which are Category A (Higher Educational Student/ Any Recognized Institutional Students in Malaysia) and Category B (Primary/ Secondary School Students / Special Education School Students in Johor). Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students from both categories and get some ideas to develop future innovation products.

A073

VOBcal: VARIANT OF BRACKETING METHOD CALCULATOR

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ABSTRACT

A variety of real-world problems can be in the form of root findings or non-linear equations. The solution to such non-linear problems can be obtained either analytically or numerically. However, analytical methods are quite complicated and difficult to be conducted. Although the numerical method offers fast and less time-consuming solutions, it requires initial guesses and repetitive calculations. Thus, there is a need to simplify all the processes to enhance the efficiency and reduce human error. Generally, there are a lot of existing and available mathematical software that can be used to solve non-linear problems. However, some consumers are always concerned about the cost of the license. Therefore, the use of a graphical user interface, which can provide a user-friendly method of entering parameters and presenting results, is one approach to solve this. The VOBcal, also known as the Variant of Bracketing method calculator, is a standalone application developed using MATLAB App Designer that uses bracketing methods to determine the root of a function. The interface of VOBcal contains five different variants of bracketing methods which are Bisection, Modified Bisection Algorithm, Trisection, and Regula Falsi programmed together with MATLAB built-in function named fzero. VOBcal can be used as a mathematical tool for research and development (R&D) purposes as well as providing effective learning and educational support for academics and researchers.

Keywords: Bracketing method, root finding problem, MATLAB-GUI, non-linear

1.0 INTRODUCTION

Finding the zero-values or roots of equations is important for many real-world fields including engineering, economics, physics, chemistry, and biology. The root findings problem could be solved directly by solving $f(x) = 0$ through factorization. However, factorization method or other analytical methods work well for linear functions, but not for nonlinear ones. Nonlinear functions are more complex and often require numerical methods to approximate their roots. Although numerical methods offer fast and less time-consuming solutions, they require initial guesses and repetitive calculations. Therefore, there is a need to simplify all the processes to enhance efficiency and reduce human error. One approach to solve this is by using a graphical user interface (GUI), which can provide a user-friendly method of entering parameters and presenting results. While there is many existing mathematical software available that can be

used to solve non-linear problems, some consumers are always concerned about the cost of the license.

There is different numerical algorithm for root-findings, and they can be classified into two main categories: bracketing methods and open methods. Bracketing methods are based on the idea of enclosing a root within an interval and then reducing the size of the interval until the root is approximated within desired accuracy. Open methods, on the other hand, are based on the idea of generating a sequence of points that converge to a root, without necessarily having an initial interval that contains the root. Both types of methods have advantages and disadvantages, depending on the properties of the function and the desired accuracy. However, open methods do not always converge but it is known to give faster solutions.

For this reason, our project will focus on bracketing methods namely Bisection, Modified Bisection Algorithm, Trisection, and Regula Falsi to solve non-linear functions.

2.0 OBJECTIVE

The objectives for this project are as follows:

i. To develop a standalone application to approximate the root of functions using some variants of bracketing methods.
ii. To provide a user-friendly means of inputting parameters and displaying results.

3.0 DESCRIPTION OF INNOVATION/METHODOLOGY

The VOBcal is an acronym for the Variant of Bracketing method calculator. It is a standalone application developed using MATLAB App Designer to calculate the root of a function by utilizing bracketing methods. MATLAB apps designer is a tool to create GUIs for the MATLAB applications and have a packaging and sharing option that enable to export the app as a standalone executable or a web app. The interface of VOBcal contains five different variants of bracketing methods which are Bisection, Modified Bisection Algorithm (Tanakan, 2013), Trisection, and Regula Falsi programmed together with MATLAB built-in function named fzero. Figure 1 below shows the complete interface for VOBcal.

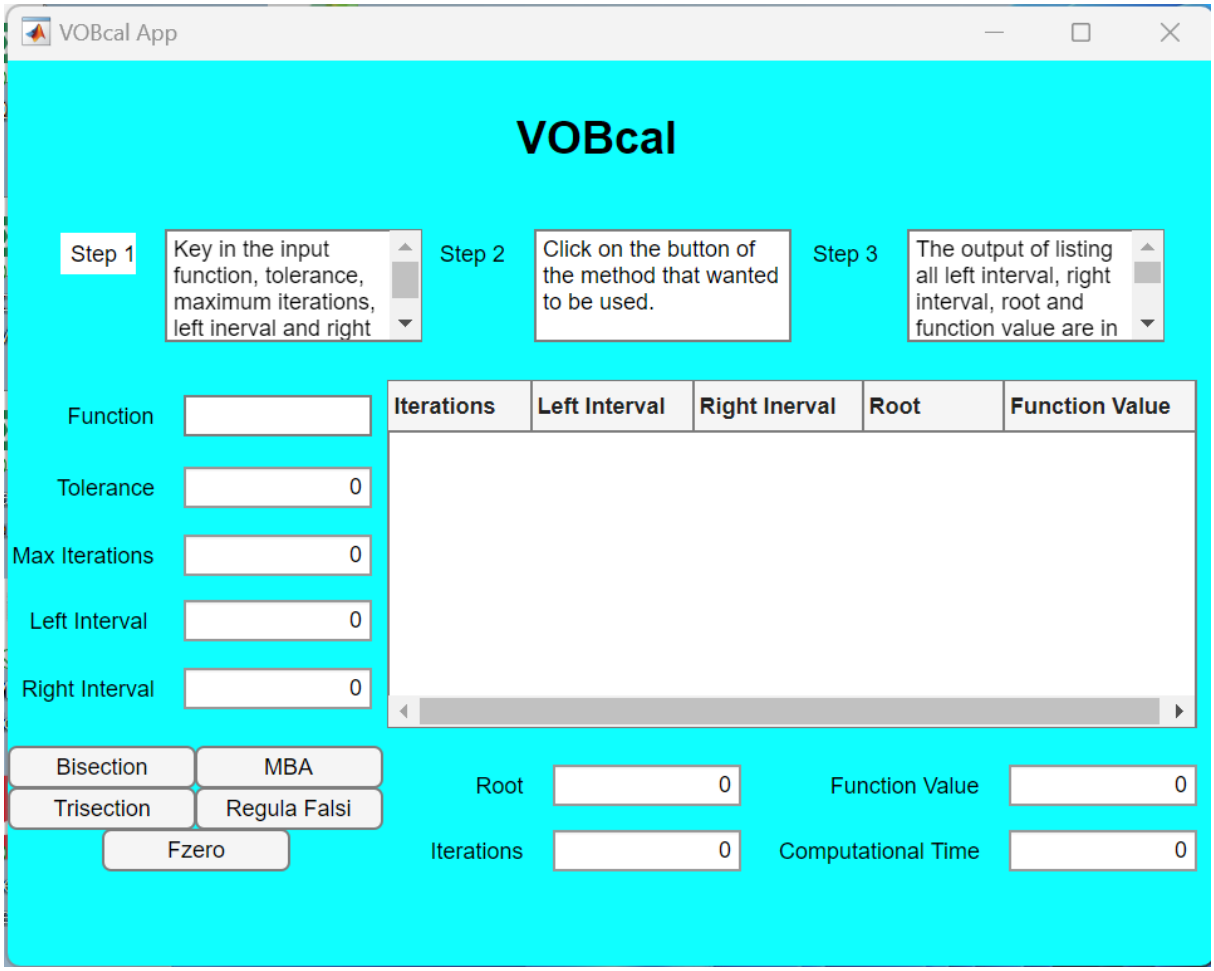

Figure 1: VOBcal interface

In order to use VOBcal apps, it is necessary to adhere to the following procedural instructions (as briefly provided in the VOBcal interface):

i. Input the function, and other necessary parameters including the tolerance value, maximum number of iterations, left interval, and right interval.
ii. Select one of the available methods, such as bisection, modified bisection method (MBA), trisection, regular Falsi or the fzero function which is the built-in MATLAB solver.
iii. The results can be observed in a tabular format, displaying the iterations, left and right intervals, values of x (root), f(x) for each individual step. Additionally, the total iteration, calculation time, the final value of variable x and the corresponding function value at the last iteration can be observed.

As a simulation, we will solve $f(x) = 7sin(2\pi x)^2$ in the interval [1,2], using Trisection method and example of results as shown in Figure 2.

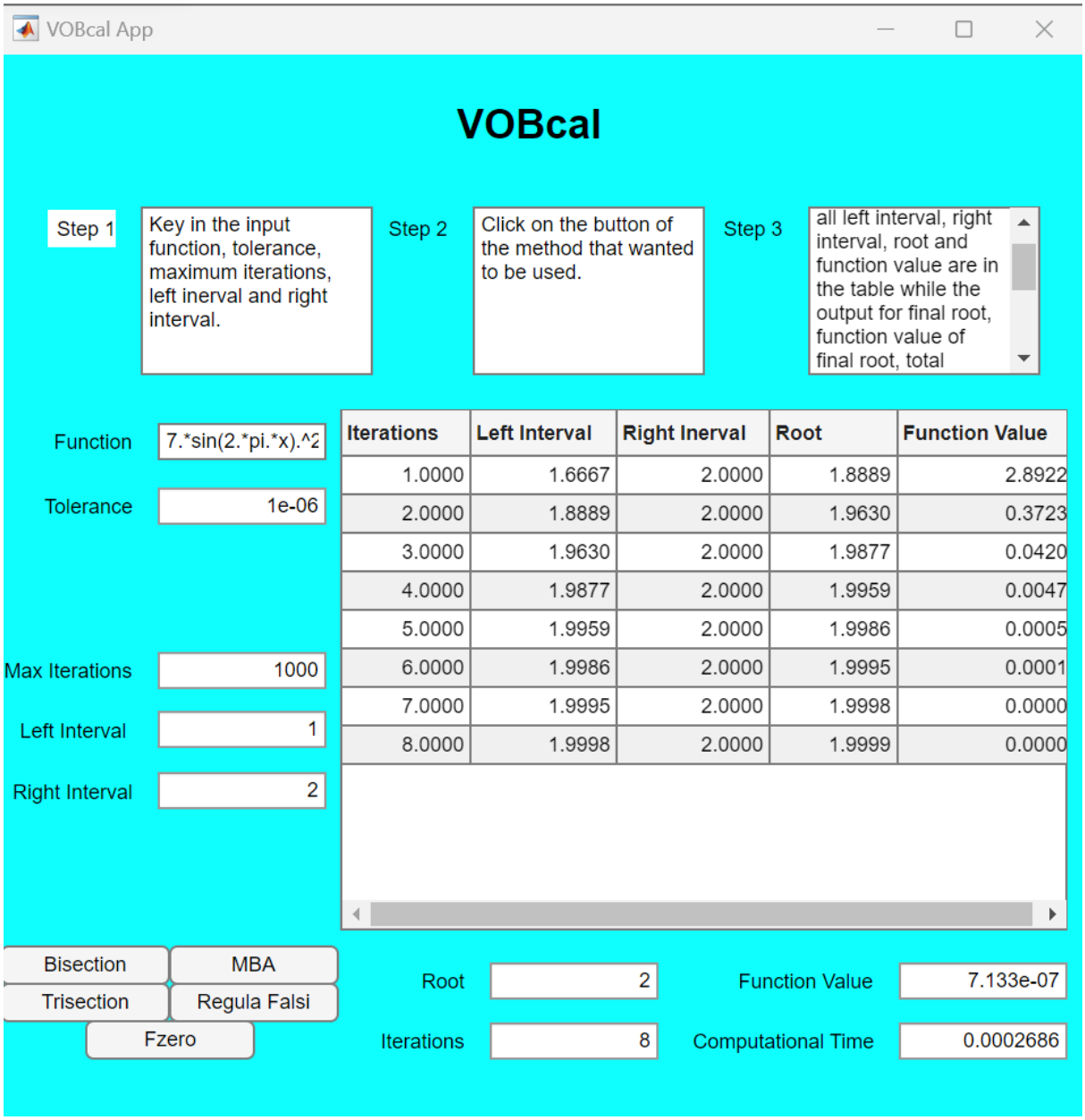

Figure 2: Example of results display using Trisection method

Table 1: Sample of results by using VOBcal

Method	Root,x	$f(x)$	Iteration	Time (s)
Bisection	1.5	9.448486630769701e-31	1	0.0000067
MBA	- 8.3986547829064e	5.249999999999991	1000	0.0029398
Trisection	1.9999491947365746	7.133048501372907e-7	8	0.0003407
Regula Falsi	0.6666666666666667	5.250000000000003	1000	0.0022683
fzero	Fail to solve	-	-	-

If the user is dissatisfied with the outcome obtained using the Trisection approach, they have the option to select alternative ways. Table 1 presents a comprehensive summary of the

results produced from all accessible methods in VOBcal. In this particular instance, the fzero method was unsuccessful in finding a solution. Similarly, both the MBA and trisection methods might be deemed unsuccessful as they hit the maximum number of iterations and the function value diverged from zero. The Bisection method is considered the most favourable approach due to its ability to provide a solution within a single iteration and yield a solution that is closest to zero. Hence, the user will be able to select the preferred solution by considering either the end function value that approaches zero, or the way that requires the fewest iterations or calculation time.

4.0 ADVANTAGE/IMPACT/RESULTS/NOVELTY

The simplest way among root finding method to solve nonlinear equation is by using Bisection Method. Bisection Method had been evolved through year to counter the flaws of the conventional Bisection Method. This method can be even simpler if using a solver in programming language. MATLAB has a feature to create GUI. The algorithms created in MATLAB run in the background and do their jobs, but MATLAB also places a strong focus on human contact, which is why it also gives us access to a graphical user interface (GUI) that can be used to build an intuitive front-end interface for our algorithm. The purpose of this project is to create a solver to solve nonlinear equation using Bisection Method and its variance using MATLAB GUI. With this, it can avoid human error so the answer will be more precise and can be used easily for many collaborations.

Furthermore, MATLAB has a flexible software structure which comprise of libraries, models, and programs that enable developer to integrate different model components in one package conveniently (Nasiruzzaman, 2010). In addition, MATLAB can expand or upgrade the developed application quickly and also provides good environment in creating or improving the GUI. That is why the creation of the VOBcal is best developed using MATLAB.The VOBcal itself does not require user to spend a lot of time in learning how to use the application. This is because the instruction and manual guide is already designed to appear on the GUI so that the first-time user can follow the instruction step by step. The position of input text fields and buttons are also arranged accordingly and systematically so that user can do the input and run the calculation with ease and quickly.

After the VOBcal has been deployed as a standalone application, a survey has been conducted for pilot-testing on the usability of VOBcal. As a result, few alterations were suggested for the improvement of the next development cycle such as the choice of colour for the interface and the position of the text field for the user to key in the necessary inputs. Therefore, developers for VOBcal will continue to enhance the graphical appearance and its usability in future development phase cycle. Thus, it will leads for future innovation plan for upgrading more features in VOBcal and other calculator apps.

5.0 CONCLUSION

VOBcal provides more intuitive and user-friendly interfaces so that the user can easily input data, run calculation and capture the results whilst reducing human errors and learning time. Therefore, developing standalone apps for solving nonlinear problems using bracketing methods in MATLAB app Designer is a powerful tool that can save time, guarantee accuracy for calculation and ease of use. Hence, VOBcal can be used as mathematical tool for many areas and purposes in solving nonlinear problems.

Acknowledgement

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