UNIVERSITI TEKNOLOGI MARA

Public Interest Centre of Excellence

International Teaching Aid Competition 2023

Reconnoitering Innovative Ideas in Postnormal Times

iTAC 2023

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INTERNATIONAL TEACHING AID COMPETITION
E-PROCEEDINGS

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PREFACE

iTAC or International Teaching Aid Competition 2023 was a venue for academicians, researchers, industries, junior and young inventors to showcase their innovative ideas not only in the teaching and learning sphere but also in other numerous disciplines of study. This competition was organised by the Special Interest Group, Public Interest Centre of Excellence (SIG PICE) UiTM Kedah Branch, Malaysia. Its main aim was to promote the production of innovative ideas among academicians, students and also the public at large.

In accordance with the theme "Reconnoitering Innovative Ideas in Post-normal Times", the development of novel ideas from the perspectives of interdisciplinary innovations is more compelling today, especially in the post-covid 19 times. Post-pandemic initiatives are the most relevant in the current world to adapt to new ways of doing things and all these surely require networking and collaboration. Rising to the occasion, iTAC 2023 has managed to attract more than 267 participations for all categories. The staggering number of submissions has proven the relevance of this competition to the academic world and beyond in urging the culture of innovating ideas.

iTAC 2023 committee would like to thank all creative participants for showcasing their innovative ideas with us. As expected in any competition, there will be those who win and those who lose. Congratulations to all the award recipients (Diamond, Gold, Silver and Bronze) for their winning entries. Those who did not make the cut this year can always improve and join us again later.

It is hoped that iTAC 2023 has been a worthy platform for all participating innovators who have shown ingenious efforts in their products and ideas. This compilation of extended abstracts published as iTAC 2023 E-Proceedings contains insights into what current researchers, both experienced and novice, find important and relevant in the post-normal times.

Best regards,

iTAC 2023 Committee
Special Interest Group, Public Interest Centre of Excellence (SIG PICE)
UiTM Kedah Branch
Malaysia

A GRAPHICAL USER INTERFACE TO APPROXIMATE AREA (AMOEBA) USING TRAPEZOIDAL METHOD FOR TEACHING AND LEARNING PROCESSES

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ABSTRACT
The trapezoidal method plays a crucial role in mathematics and numerical analysis for approximating the area under a curve. We present a user-friendly Graphical User Interface (GUI) designed for educational purposes to facilitate effective teaching and learning of this method. The GUI provides an interactive platform that engages students and educators in a visually appealing and user-friendly environment. The GUI's features improve teaching and learning. Students may enter functions and choose approximation intervals. The interface shows the curve and trapezoids that approximate its area. Students may see how changing the number of trapezoids affects approximation accuracy. The GUI allows real-time function and interval modifications for clarity. This lets students see how function changes affect estimated area. The GUI provides fast feedback and allows comparisons with known precise solutions by displaying the estimated area numerically. Experimental learning is encouraged by the GUI. Students may explore functions and intervals, notice the approximations, and compare the results. This hands-on approach helps comprehend the trapezoidal technique and its practical applications. The interface's graphics enhances learning. Visualizing trapezoidal approximation helps students understand the math. The GUI also helps educators convey the trapezoidal approach graphically, helping students understand the material. The proposed Graphical User Interface for

teaching and learning the trapezoidal method is an effective educational aid for numerical analysis in general. Through its interactive features, real-time visualizations, and user-friendly layout, the GUI facilitates comprehension, inquiry, and engagement, ultimately augmenting the learning experience and fostering a deeper comprehension of the trapezoidal method and its applications.

Keywords: graphical user interface, numerical analysis, trapezoidal rule, approximation, interactive

INTRODUCTION

A Graphical User Interface (GUI) makes it easier to teach and learn the Trapezoidal Method for approximating areas. The goal of the GUI is to solve problems with standard ways of teaching, such as limited visual representation, lack of engagement, complexity, and limited input in real time. It also aims to help students understand, be interested in, and think critically by using visualizations, animation, and easy-to-use tools. The trapezoidal method is one of the most important ways to estimate the area under a curve in mathematics and numerical analysis. But without good visuals and hands-on experiences, it can be hard for students to understand its academic roots and real-world uses. The GUI connects abstract mathematical ideas to real-world uses. It lets students interact with dynamic models, change factors, and see how their changes affect the process of approximating areas right away. The GUI not only helps students, but it also gives teachers the tools they need to teach more effectively. With its easy-to-use layout, clear directions, and engaging features, the GUI helps teachers explain complicated ideas, start talks in the classroom, and give students quick feedback. By adding game-like features, it increases motivation and keeps people interested, making the learning process more fun and effective. This extended abstract describes the goals of the GUI, which are to improve understanding, encourage active learning, give feedback in real time, encourage critical thinking, and make training more efficient. By achieving these goals, the GUI hopes to change the way area approximation using the trapezoidal method is taught and learned. This will give students important math skills and help them understand how numerical analysis is used in the real world. In short, this extended outline shows a GUI that uses visual representation, engagement, and ease of use to help teach and learn the trapezoidal method for approximating areas. The GUI gets around the problems with traditional methods, encourages active participation and critical thinking, and gives teachers a way to make a learning experience that is engaging and involved.

MATERIAL

Numerical Analysis

Numerical analysis is a field of mathematics and computer science that focuses on making and analyzing programme that use numbers to solve math problems. It is the study of different numerical methods and techniques that are used to get close to the answers to maths problems or equations that are hard or impossible to solve directly. Numerical analysis is used in many different fields, such as engineering, physics, economics, computer science, and many more. It is a key part of scientific study, data analysis, modelling, and the creation of industrial systems (Burden, 2010).

Trapezoidal Rule

The trapezoidal rule is a way to estimate the definite integral of a function by splitting the interval into smaller trapezoids and adding up their areas. It gets close to the integral by modelling the function as a set of linear parts (Burden, 2010). The trapezoidal rule is based on the method in which curve *f* is approximated with straight line, *L*, as shown in Figure 1.

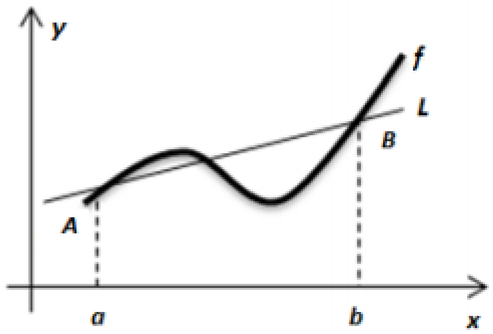

Figure 1. Approximation of the Curve *f* with straight line *L*
(*Source:* Pavičić et al., 2018)

The area of the trapezoid is obtained by integrating function L (Equation 2.1)

$$L(x) = \frac{f(b)-f(a)}{b-a}(x-a)+f(a) \quad (2.1)$$

on the interval [a,b], so

$$\int_a^b f(x)dx \approx \int_a^b L(x)dx = \frac{b-a}{2}\left(f(a)+f(b)\right) \quad (2.2)$$

There are possible of errors with this method. Thus, it is necessary to divide the interval [a,b] into several sub-intervals of equal length with points 0, 1, 2, … , and , as shown in Figure 2.

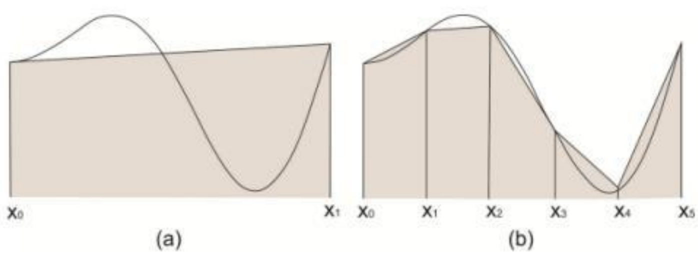

Figure 2. Trapezoidal Method with One Interval (a) and Five Subintervals (b)
(*Source*: Pavičić et al., 2018)

The final form of the trapezoidal rule formula is:

$$\int_a^b f(x)dx \approx \frac{h}{2}\left(y_0 + y_n + 2(y_1 + y_2 + \cdots + y_{n-1})\right) \tag{2.3}$$

where,

$$y_0 = f(x_0), y_1 = f(x_1), \ldots, y_{n-1} = f(x_{n-1}), y_n = f(x_n);$$

$$h = \frac{b-a}{n} = length\ of\ each\ subinterval \tag{2.4}$$

Simulator

A simulator is a method, device, or computer programme that simulates something. In other words, a simulator or computer simulation is the running of a model expressed by a computer programme that gives information about the system being studied. Durán (2019) says that computer models are problem-solvers because they have two things in common. First of all, the computer programme gives answers to all of the questions about how to use, explain, and build a model that uses math that is hard to analyse. Second, computer simulation helps solve problems when the math model is too complicated to examine or when the analysis methods don't work. So, computer modelling is a way to help figure out how to solve a maths problem (Durán, 2021).

RESULTS AND DISCUSSION

The analysis of the results from the simulator for approximating the area using the trapezoidal area is recorded to check whether the objectives of the project have been achieved. Other than that, the purposes of this analysis are to test the functionality and the accuracy of the system. The project was tested using function equations and data of the asymmetrical shapes. Then, a comparison of the approximation area between the simulator, the calculation by hand and the actual area was done.

Input Coordinate Amoeba

A set of data have to be keyed in the table in order to calculate the approximate area using Trapezoidal Rule. Table 1 shows a set of data for an amoeba that will be input into the simulator.

Table 1. Table of x, y1 and y2 for Amoeba

x	y1	y2
2.5	10.0	10.0
5.0	12.5	2.5
7.5	17.5	5.0
10.0	15.0	5.0
12.5	17.5	2.5
15.0	17.5	2.5
17.5	15.0	7.5
20.0	15.0	10.0
22.5	15.0	10.0
25.0	12.5	12.5

Then, the data are inserted in the data table in the graphical user interface. Figure 3 shows the input of the data and after the Compute Area button have been pressed to display the result of the approximation area.

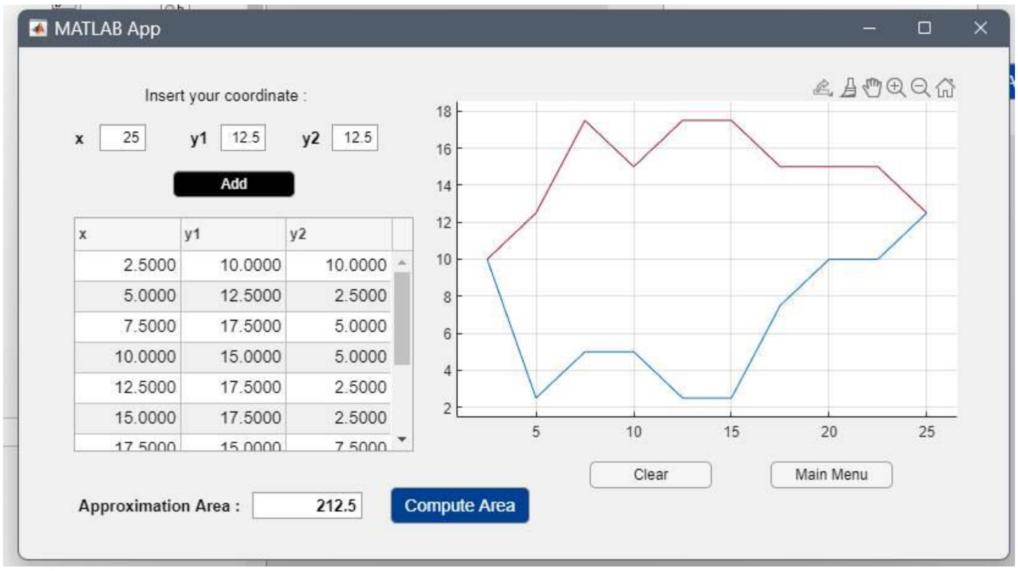

Figure 3. Figure Header

Each time the Add button is pressed, the graph will automatically sketch the approximation area in the graph. Since the approximation of the area is displayed, the Compute Area button is functioning well using the data table computation. The functionality testing shows that all the buttons and components are functioning well. This shows that all the callback functions coded in the system are able to give the intended result on display components. Thus, the accuracy testing will be done to check the output accuracy for related components.

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