

Determining Perimeter Using the Newton Backward Divided Difference Interpolation Formula for Teaching and Learning Process

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Abstract: This Newton Perimeter Solver was designed to help the students, educators, and others. The purpose of this research is to find the perimeter by using the Newton Backward Divided Difference. The problem statements that occur while manually computing the perimeter are the first one is people often make mistakes when calculating distance manually due to the numerous steps involved in the process. Additionally, they tend to mix up unit types because they find it confusing to perform unit conversions. Next, people tend to make mistakes when rounding data, particularly when dealing with large numbers and lengthy decimal values. These errors can significantly impact the overall accuracy of the final distance calculation. Lastly, manual calculation leads to an increase in time consumption and higher operating costs because they need to double-check all calculations to ensure the accuracy of their measurements. The solution to this problem are to improve the calculation of perimeter using the Newton Backward Divided Difference Interpolation method and then to determine the mathematical equations in order to obtain the perimeter. Lastly, to handle large datasets and perform calculations at a much faster than manual. Finding the total perimeter, on the other hand, is quite time intensive in order to optimally perform the calculation. As a result of the existence of this Newton Perimeter Solver, the computations required may be simply retrieved by valuable information from the user. This Newton Perimeter Solver was designed in the form of The Newton Backward Divided Difference Interpolation Formula (NBDDI) to assist the calculation of perimeter for all people. The interface displays the graph as well and the arc length of the curve.

Keywords: Newton Backward Divided Difference; Perimeter Calculation; Newton Perimeter Solver



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1. INTRODUCTION

The use of computer technology in educational settings as a tool for teaching and learning is becoming more common (Tomić, 2013). In our current day, practising the use of mathematical software might make the learning process simpler. Many mathematical software systems have been

developed to assist students and workers in easily doing various computations. The use of computer technology can improve students' learning by presenting knowledge quantitatively, visually, and symbolically without the extra strain of spending time manually solving complicated computational issues (Aungamuthu, 2013).

Several studies by (Hamzah & Hidayat, 2023) report that Geogebra software can help students enhance their accomplishment, conceptual comprehension, motivation, visualization abilities, engagement, interest, critical thinking ability, mathematical reasoning, and problem solving skills. Using mathematical software is more convenient. Study by (Ochkov & Bogomolova, 2015) state that they emphasize in particular that the ability to visualize final answers is highly significant in most circumstances, and contemporary mathematical software packages provide users with straightforward and simple visualization and even animation capabilities. By including them into their teaching team, they may considerably improve their students' knowledge of basic mathematical ideas and theorems. The goal of this research is to make computations more convenient by applying mathematical software.

2. METHOD & MATERIAL

The Newton Backward Divided Difference Interpolation Formula is a numerical technique employed to approximate functions or data points, especially when only a limited number of data points are available. It proves particularly beneficial for estimating values near the end of a given interval or datasets. When applied to calculating perimeter and distance, this formula aids in determining approximate values based on just a few key data points. Here's a step-by-step breakdown of how it works:

Data Collection: Begin by gathering the available data points that represent an object's positions at specific time intervals. This data serves as the foundation for the interpolation.

Data Sorting: Organize the data points in ascending order based on the time intervals or any relevant parameter. This step is essential for the interpolation process.

Divided Differences: Calculate the divided differences for the given data points. These divided differences represent the variations between consecutive data points, divided by the difference between their corresponding time intervals. These differences are the building blocks of the interpolation.

Backward Divided Difference Coefficients: Use Newton's backward difference formula to determine the coefficients for the divided differences. These coefficients are crucial for the subsequent interpolation process.

Interpolation: With the coefficients in hand, employ the backward divided difference formula to estimate the value of interest, such as the perimeter or distance, at a specific point in time or position. This step provides the approximate value you seek.

It's critical to understand that the distribution and quality of the available data points affect how accurate the interpolation will be. It is also important to keep in mind that interpolation can cause inaccuracies when using the estimated numbers. Furthermore, a Newton Perimeter Solver has been developed in order to enhance and simplifies the application of this technique. This solver includes graphical representations of curves and arc lengths in addition to making perimeter and distance calculations easier. It is organised according to The Newton Backward Divided Difference Interpolation Formula (NBDDI). This solver is an invaluable resource for a variety of applications since it allows users to efficiently input their data and provide the appropriate results.

3. FINDINGS

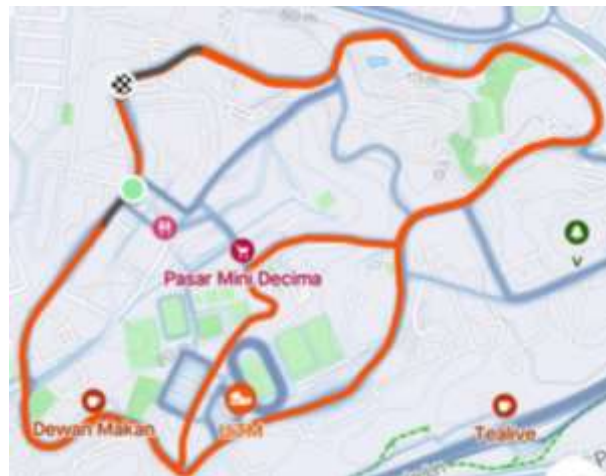


Figure 1. Reference photo of the UiTM Shah Alam map

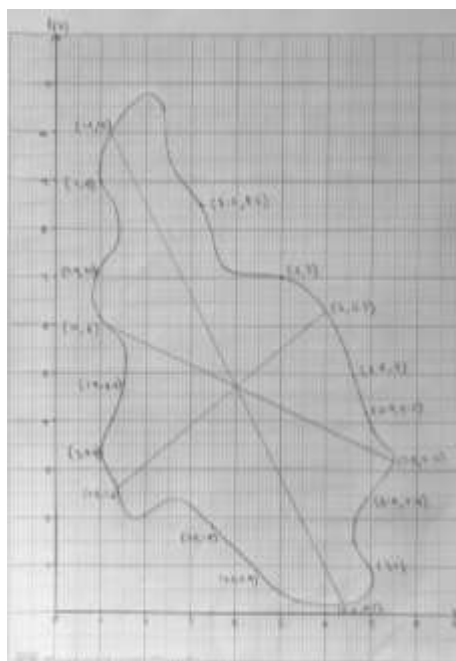


Figure 2. Plotted data and hand drawn graph with respect to the reference map

3.1 Construct the finite divided difference table.

X	6.4	7	6.9	7.5
F(x)	0.2	1	2.4	3.2

3.2 Determine the reference value x^n located near the bottom of the table.

$$x_3 = 7.5$$

x_i	$f(x_i)$	First divided difference	Second divided difference	Third divided difference
6.4	0.2			
		1.3		
7	1		-30.6	
		-14.0		55.6
6.9	2.4		30.6	
		1.3		
7.5	3.2			

3.3 Identify the corresponding value for k^{th} divide difference.

$$f(x_3) = 3.2$$

$$f(x_2, x_3) = 1.2$$

$$f(x_1, x_2, x_3) = 30.6$$

$$f(x_0, x_1, x_2, x_3) = 55.6$$

3.4 Apply the newton backward divided difference interpolation formula.

$$P_n(x) = f[x_n] + f[x_{n-1}, x_n](x - x_n) + f[x_{n-2}, x_{n-1}, x_n](x - x_n)(x - x_{n-1}) + \dots$$

$$+ f[x_0, x_1, x_2, \dots, x_n](x - x_n)(x - x_{n-1})(x - x_{n-2}) \dots (x - x_1)$$

$$P_n(x) = f[x_3] + f[x_2, x_3](x - x_3) + f[x_1, x_2, x_3](x - x_3)(x - x_2) + f[x_0, x_1, x_2, x_3](x - x_3)(x - x_2)(x - x_1)$$

$$P_n(x) = 3.2 + 1.3(x - 7.5) + 30.6(x - 7.5)(x - 6.9) + 55.6(x - 7.5)(x - 6.9)(x - 7)$$

$$= 3.2 + 1.3(x - 7.5) + 30.6(x - 7.5)(x - 6.9) + 55.6(x - 7.5)(x - 6.9)(x - 7)$$

$$= 55.6x^3 - 1159.2x^2 + 2285.1x + 18569.0$$

$$\text{arc length} = \int_a^b \sqrt{1 + [f'(x)]^2} dx$$

$$f(x) = 55.6x^3 - 1159.2x^2 + 2285.1x + 18569.0$$

$$f'(x) = 166.8x^2 - 2318.4x + 2285.1$$

$$= \int_{6.4}^{7.5} \sqrt{1 + [166.8x^2 - 2318.4x + 2285.1]^2} dx$$

$$= 6329.51$$

- Arc length from (6.4,0.2) to (7.5,3.2) is 6329.51



Figure 3. First interface: To proceed to the next page, press the "START" button.

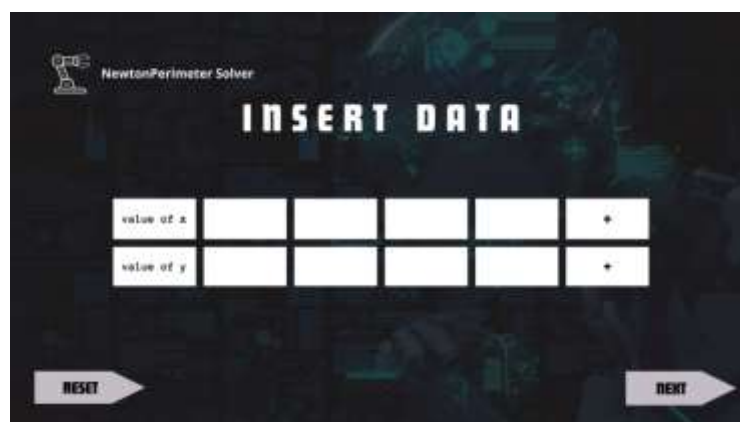


Figure 4. Second interface: User key-in the required inputs and press "next".

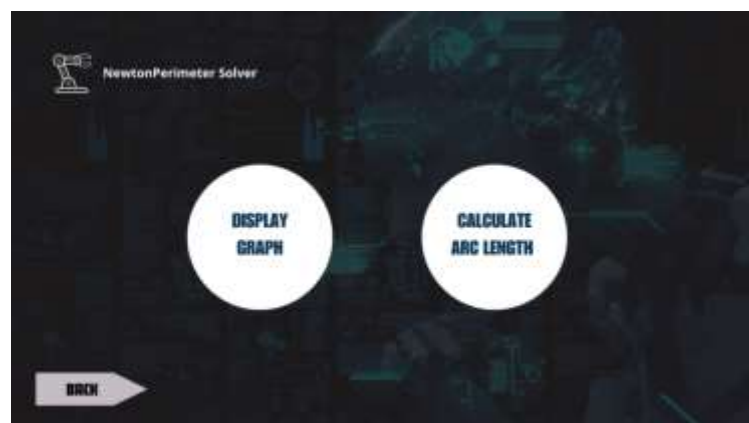


Figure 5. Third interface: Choose to display a graph or to obtain the arc length.

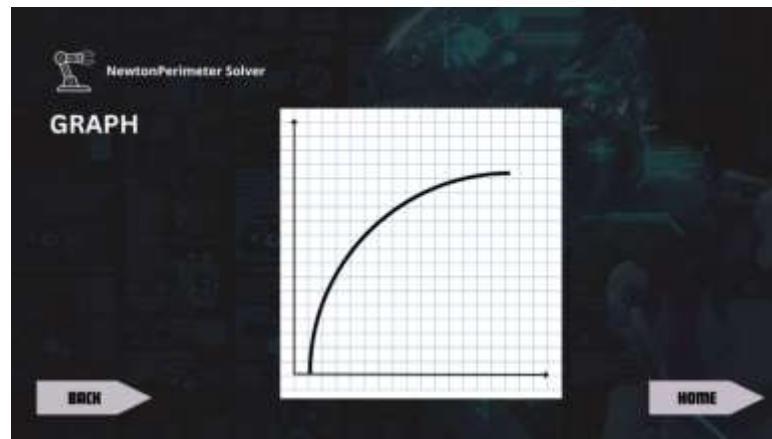


Figure 6. Curve of the graph interface: The graph will display. Press “BACK” to go to the previous interfaces

Figure 7. Arc length interface: Insert the initial and ending points to be used for the definite integral to calculate the arc length. Press “HOME” to insert another data.

4. DISCUSSION

To calculate the perimeter by using manual calculation, we need to provide the set of data points x and y from the graph in Figure 2. We divide the graph into numerous curves to make the computation process easier with a smaller number of data points. Then, construct the finite divided difference table. Next, we can obtain the equation of the curve by using the Newton Backward Divide Difference Interpolation formula. We can then use the formula for arc length to obtain the arc length from a single curve. The definite integral is used in the computation of the arc length. Then, we must repeat the steps from provide the set of data points x and y from the other curve and repeating the operation until we have obtained all of the arc lengths from each curve. Finally, we may add all of the arc lengths to get the perimeter of the one-round UiTM Shah Alam.

This Newton Perimeter Solver was designed to calculate the perimeter in a convenient way. It calculates significantly faster and more precisely than humans. By using this prototype, it can save more time and eliminate human errors. By using this Newton Perimeter Solver, the user needs to insert the values of data points x and y from one curve that can be obtained from the graph. Then, this prototype will proceed to calculate the arc length. From the third interface, the user is given two

options, which are to display the curve of the graph from the data that the user has inserted just now or to obtain the arc length. If the user is choosing to obtain the arc length, the arc length interface will be displayed. Then, they are required to insert the initial and end points in order to calculate the arc length by using the definite integral. Next, start again with the new data points from each curve to obtain the arc length. From here, the user can sum up all the arc lengths to obtain the perimeter.

5. CONCLUSION

In conclusion, The Newton Perimeter solver serves as a valuable tool for both students and professionals, providing a wide range of benefits and functionalities. With its ability to perform The Newton Backward Divided Difference Interpolation Formula to find the distance and perimeter of the curve, and also can visualize the graph, this software greatly enhances the learning and problem-solving experience. Additionally, it promotes efficiency and accuracy by eliminating human errors and allowing for quick validation of calculations. Moreover, its interactive nature and user-friendly interfaces make it accessible to users of all skill levels, fostering a deeper understanding. Overall, The Newton Perimeter solver acts as a helpful assistant, empowering users to explore, comprehend, and excel in the vast world of mathematics.

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