

MATH-151 Lab 6: Differentiation Methods

Due: Monday, October 9, 2023, 10:00am

Please perform the following tasks using Matlab, submitting all relevant code. You are welcomed to work with other students, however each student must submit their own unique code.

Task 1: A Speeding Object!

Similar to what we saw last week, it is very common to use these methods with real world measurements to estimate derivatives without having a known function. For this problem, please download Lab06.Data.mat from the course Canvas page and make sure it is located in the same folder as your script. You can load this data into Matlab using `load('Lab06_Data.mat')`, this should add vectors `time` and `pos` to your workspace.

- a) Using the central difference method, calculate and plot your estimate of this object's speed.
(Note: Because the central difference method needs your x value to be in the center you may use the appropriate finite difference methods for the first and last values)
- b) Say we are also interested in this object's acceleration over time. Calculate and plot an estimate of the second derivative from this data.

Task 2: Method Comparison

We learned that finite difference and central difference methods of numerical differentiation have differing orders of error. Hopefully, this makes some sense mathematically but lets take a second to look at what this means in an example. We will consider the function

$$f(x) = \sin\left(\frac{x}{3}\right)^2$$

with derivative

$$f'(x) = \frac{2}{3} \left(\sin\left(\frac{x}{3}\right) \cos\left(\frac{x}{3}\right) \right)$$

- a) Use finite difference method to compute an approximation of $f'(x)$ from $-\pi$ to π using a step size of 0.5. Plot this approximation on the same axis as the true $f'(x)$ function given above.
- b) Now approximate $f'(x)$ using the same x grid using the central difference method. Plot this function on the same axis used in part (a). How do these approximations compare? Which looks more accurate.
- c) In a new figure, plot the errors (true values - estimated values) for each of these methods. Is there a difference between these methods? Which is more accurate?

Some lab specific reminder?