Programming Lab 6 – Area Under a Curve
PHYS 2511 – Prof. Matthew Newby – Spring 2020

Goal:	Use rectangles to find the area under the curve for several functions.
Requirements:	Create a program that estimates the area under a curve, using a series of rectangles, for three separate functions (see below), and show how the accuracy changes based on your choice of rectangle widths.
Inputs:	• Rectangle widths (Δx)
Outputs:	• Area under the curve. • Percent difference compared to true area under curve. • The trend (table or figure) if the percent difference as a function of x step size.
Optional:	• Also implement a Monte-Carlo integration technique • Compare your results with those of scipy.integrate.quadrature() • Plot the function and rectangles for one or more implentations

Background:

You will find the area under 3 curves, over the interval x = -5.0 to 5.0:

- Straight line: $y_1 = -0.5\ x + 4.0$
- Parabola: $y_2 = -0.29\ x^2 - x + 12.5$
- More Complicated function: $y_3 = 1.0 + 10*(x + 1.0)*\exp(-x^2)$

To find the area under the curve, you will make rectangles that meet the curve and add the areas of the rectangles together. The width of these rectangles will be chosen by you, and the height will be given by the y value of the curve at some point in the rectangle. This technique is known as the *rectangle rule*. For example, see rectangles drawn below, with the height of each rectangle given by the y-value of the curve at the middle of the rectangle:

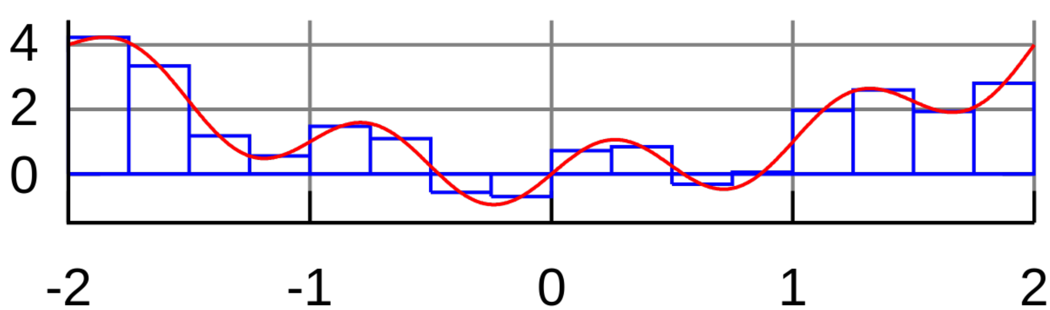

Illustration of Rectangle Rule (Emergie, Wikimedia Commons)

You will then vary the width of the rectangles, and see how the area accuracy differs with rectangle width. The true area under each curve over the given interval is:

y_1: 40.0
y_2: 100.83
y_3: 27.72

Ideally, you should create a plot of percent difference versus Δx for each function.