PHYS 210, Assignment 10

Create a new directory somewhere in your home directory with the name `yourusername_assignment_10` to store the files you will create for this assignment. To hand the assignment in, copy the directory with your results to `/home2/phys210/yourusername/`. Make sure it's there and has the right permissions (read and execute for everyone, write for you).

1 Lists and Tuples I

Write all the functions below in a script `containers.py`. None of your functions should generate an error if called with an empty list or a single element list.

- Write a function that takes a list of numbers `t` and returns a tuple of only the first and last elements of the given list. You will call this function `list2tupleends(t)`.
- Write a function that takes a list `t` and returns a new list containing the elements of the first list without duplicates. Call this function `noduplicates(t)`.
- Write a function which tests if a string `s` is a palindrome or not (a palindrome is a word that reads the same forward and backward). Call this function `palindrome(s)`.
- Write a function that take a list of numbers `t` and returns a new list containing all elements smaller than 10 with no duplicates. Call this function `lessthanten(t)`.
- Write a function that takes a list `t`, removes the first and last elements, modifies it *in place* and returns `NoneType`. You will call this function `truncate(t)`.

2 Numerical Integration I

The simplest numerical integration technique uses the *midpoint rule*. The definite integral of a function $f(x)$ over the interval $x = [x_0, x_n]$ is approximated as a sum of rectangle areas of equal width $\Delta x = \frac{x_n - x_0}{n}$ and height determined by the value of the function $f(x_i^\star)$ at the midpoint position $x_i^\star$. This is illustrated in Figure 1. Mathematically it is given by:

$$\int_{x_0}^{x_n} f(x)\mathrm{d}x = \Delta x \left(f(x_1^\star) + f(x_2^\star) + ... + f(x_{(n-1)}^\star) + f(x_n^\star) \right) \tag{1}$$

- Write a function called `midpoint`(n, x_0, x_n) which calculates the integral of $f(x) = \sin(x)\exp(-x/2)$ over the interval $x = [x_0, x_n]$ where x_0, x_n and n are arguments of the function `midpoint( )`.
- Write a script called `integrate_func.py` which calculates the integral of $f(x)$ over the interval $x = [-1, 2\pi]$, for the values of $n = [10, 20, 100, 200, 400, 800, 1600]$. Write your script so that it also plots the value of the integral for different values of n, save your plot as a pdf file called `plot_func.pdf`. Don't forget to label both axis.

- The indefinite integral of $f(x)$ is $F(x) = -\frac{2}{5}\exp(-x/2)(\sin(x) + 2\cos(x)) + constant$. On the same plot of the previous question, indicate with a horizontal dashed line the exact value of the integral. Use a legend box to indicate which line is the exact calculation, which line is your numerical integration. For which value of n, the numerical integration has a precision of $\sim 10\%$ compared to the exact value? Write this value of n in a file called `precision.txt`.

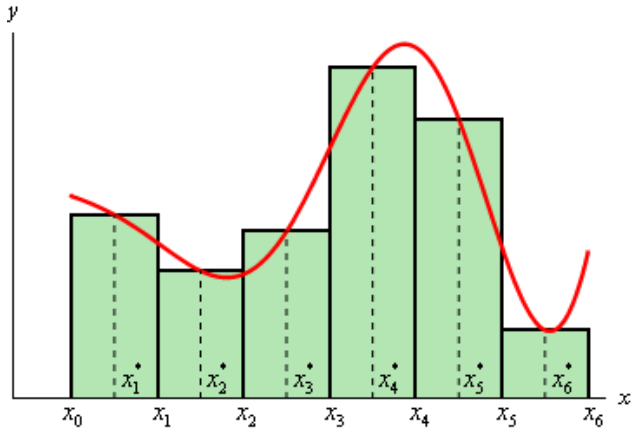

Figure 1: Illustration of the midpoint numerical integration technique.