Assignment: Numerical Integration

What you need to submit

- Submit the report+source files as a zip file online (LMS)
- **Report:** including pseudocode, output results, and source codes as instructed
- **Src Code:** (1) **Assignment_integration_Name_ID.cpp, (2) myNP.h, (3) myNP.cpp**
- All the functions you have created should be updated in myNP.h and myNP.cpp

Use the tutorial code: download source file here

Integration from Datasets

Here, we DO NOT assume evenly distributed data. Estimate the position from the dataset of velocity

```
clear all
x=[0 5 10 15 20 25 30 35 40 45 50 55 60];
y=[0 3 8 20 33 42 40 48 60 12 8 4 3];
N=length(x)
```

```
I= 1397.500000  (Matlab output)
```

Problem 1:

Create a Trapezoidal method function for discrete data inputs.

double trapz (double x[ ], double y[ ], int m)

In the report, screen capture the output window and paste your code

- Use 1D array type with dataset length m.
- # intervals= N, # dataset=N+1=m, The ranges are x[0] to x[N]

$$I(f)=\frac{1}{2}\sum_{i=0}^{N-1}\left[f\left(x_i\right)+f\left(x_{i+1}\right)\right]\left(x_{i+1}-x_i\right)$$ // different intervals

Problem 1

Pseudo code

$N = m - 1$

for (i = 0 ; i < N ; i++)

$$I \mathrel{+}= \frac{(x_{i+1} - x_i)}{2} * (f(x_i) + f(x_{i+1}))$$

end

Output

```
**************************************************
       Problem 1. Integration from Datasets
**************************************************
I_rect  = 1390.000000
I_trapz = 1397.500000
```

Integration from Datasets with the same interval

Problem 2:

X=[-3	-2.25	-1.5	-0.75	0	0.75	1.5	2.25	3]
Y=[0	2.1875	3.75	4.6875	5	4.6875	3.75	2.1875	0]

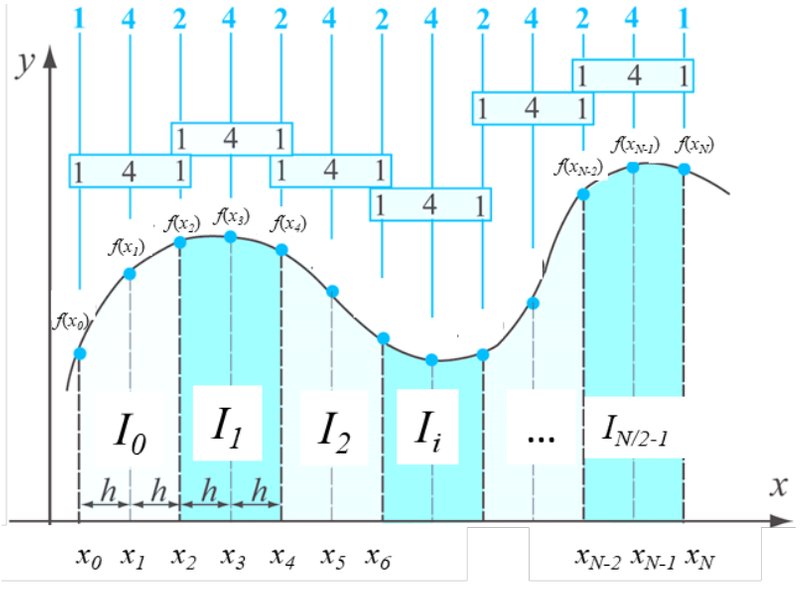
Create Simpson13() for discrete data inputs.

```
double simpson13 (double x[ ], double y[ ], int m)
```

In the report, screen capture the output window and paste your code

- Use Simpson 13 method
- # subintervals= N, # intervals= N/2, # dataset=m=N+1
- N even numbers, same interval h
- This must be defined in **myNM.cpp** source file

$$I = \frac{h}{3}[f(x_0) + 4\sum_{i=1,3,5}^{N-1} f(x_i) + 2\sum_{k=2,4,6}^{N-2} f(x_k) + f(x_N)]$$



N: Subinterval

$\frac{N}{2}$: Interval

$N+1$: data

Problem 2

Pseudo code

$N = m-1$

$h = x[1] - x[0]$

for ($K=0$; $K < \frac{N}{2}$; $K++$) {

$I += 4*y[N-(2K+1)] + 2*y[N-(2K+2)]$

}

$I = \frac{h}{3}*(I - y[0] + y[N])$

end

Output

```
*****************************************************
       Problem 2. Integration from Datasets, with the same interval
*****************************************************
I_simpson13  = 20.000000
```

Integration from a Function

Problem 3:

Create a numerical integration function when a mathemtatical function is given as the input.

- In the report, screen capture the output window and paste your code
- Create a function "myFunc()" to define the following integration. It should be defined in the **main** source file.

```
double myFunc (const double x)    // in main.cpp
```

$$I(f) = \int_{-1}^{1} \sqrt{1-x^2}\,dx \quad // \quad \text{It should be} \quad \frac{\pi}{2}$$

- Use Simpson 13 method : for N even numbers, same intervals, from a(=x0) to b(=xN), h=(b-a)/N. This must be defined in **myNM.cpp** source file

```
double integral(double func(const double x), double a, double b, int n)    // in myNM.h
```

- The interval should be h=(b-a)/N
- Choose N=12

$$I = \frac{h}{3}[f(x_0) + 4\sum_{i=1,3,5}^{N-1} f(x_i) + 2\sum_{k=2,4,6}^{N-2} f(x_k) + f(x_N)]$$

Problem 3

Pseudo code

$$h = \frac{(b-a)}{n}$$

for $(k=0;\ k<\frac{n}{2}\ ;\ k++)$ {

$$I\ += 4 * func(a + h*(2k+1)) + 2*func(a + h*(2k+2))$$

}

$$I = \frac{h}{3} * (I - func(a) + func(b))$$

end

Output

```
**************************************************
      Problem 3. Integration from a Function
**************************************************
I_integral  = 1.555063
```