CAIRO UNIVERSITY

FACULTY OF SCIENCE
DEPARTMENT OF COMPUTER SCIENCE

M351 project

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COURSE

Numerical Analysis (MATH 351)

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M351 project

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1 Mid-point rule

Mid-point rule is a method of estimating the integral of a function or the area under a curve by dividing the area into rectangles of equal width.

$$M_n = \sum_{i=1}^{n} f(m_i)\Delta x \tag{1}$$

where i is the ith rectangle, n is the number of rectangles that the area under the curve is divided into, $f(m_i)$ is the function of the curve evaluated at the midpoint of the ith rectangle, and Δx of each rectangle can be calculated using the following formulas:

$$m_i = \frac{x_i - x_{i-1}}{2} \tag{2}$$

where x_i is the x -value of the right endpoint of the ith rectangle, and x_{i-1} is the x -value of the left endpoint of the ith rectangle.

$$\Delta x = \frac{b-a}{n} \tag{3}$$

where a is the lower boundary of the interval, b is the upper boundary of the interval, and $n$is the number of rectangles.

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2 Trapezoidal rule

Trapezoidal rule is the first of the Newton-Cotes closed integration formulas, where:

$$I = \int_a^b f(x)dx \cong \int_a^b f_1(x)dx \tag{1}$$

$$I \cong \frac{f(a) + f(b)}{2}(b-a) \tag{2}$$

3 Simpson's rule

Simpson's rule is an extension of Trapezoidal rule where the integrand is approximated by a second-order polynomial, so:

$$I = \int_a^b f(x)dx \cong \int_a^b f_2(x)dx \tag{1}$$

$$I \cong \frac{b-a}{6}[f(a) + f(\frac{a+b}{2}) + f(b)] \tag{2}$$

4 Screenshots for all results for each case

assuming the problem

$$\int_1^3 x^3 - x^2 - 12dx$$

approximating this integral using the 3 methods with n = 10 our script will be like this

4.1 Trapezoidal

first using trapezoidal

```
>> project
enter used wanted method (Trap,Simp,Mid,lAnalyzis) :
Trap
enter f(x) :
x^3-x^2-12
enter a :
1
enter b :
3
enter number of iterations :
10
ans = -12.600
>>
```

4.2 Simpson's

using Simpson's

```
>> project
enter used wanted method (Trap,Simp,Mid,lAnalyzis) :
Simp
enter f(x) :
x^3-x^2-12
enter a :
1
enter b :
3
enter number of iterations :
10
ans = -12.667
>>
```

4.3 Mid-point

```
>> project
enter used wanted method (Trap,Simp,Mid,lAnalyzis) :
Mid
enter f(x) :
x^3-x^2-12
enter a :
1
enter b :
3
enter number of iterations :
10
ans = -12.700
```

4.4 Analysis

for the IAnalyzis the number of iterations entered is the number of max n and with step = 10 then if number of iterations = 100 the function calculates n = [10,20,30,40,50,.....,100] if number of iterations = 1000 the function calculates n = [10,20,30,40,50,....,100,....,1000] the function can be used like this