CAIRO UNIVERSITY

FACULTY OF SCIENCE
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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 is the width of each rectangle.

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

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 the integrand is approximated by a first-order polynomial, so:

$$I = \int_{x_0}^{x_1} f(x)dx + \int_{x_1}^{x_2} f(x)dx + ... + \int_{x_{n-1}}^{x_n} f(x)dx \tag{1}$$

$$I = h\frac{f(x_0)+f(x_1)}{2} + h\frac{f(x_1)+f(x_2)}{2} + ... + h\frac{f(x_{n-1})+f(x_n)}{2} \tag{2}$$

$$I = \frac{h}{2}[f(x_0) + 2\sum_{i=1}^{i=n-1} f(x_i) + f(x_n)] \tag{3}$$

3 Simpson's rule

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

$$I = \int_{x_0}^{x2} f(x)dx + \int_{x_2}^{x_4} f(x)dx + ... + \int_{x_{n-2}}^{x_n} f(x)dx \tag{1}$$

$$I = \frac{h}{3}[f(x_0) + 4f(x_1) + f(x_2)] + \frac{h}{3}[f(x_2) + 4f(x_3) + f(x_4)] + ...$$

$$... + \frac{h}{3}[f(x_{n-2}) + 4f(x_{n-1}) + f(x_n)] \tag{2}$$

$$I = \frac{h}{3}[f(x_0) + 4\sum_{i=1,3,5,..}^{i=n-1} f(x_i) + 2\sum_{i=2,4,6,..}^{i=n-2} f(x_i) + f(x_n)] \tag{3}$$

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,1Analyzis) :
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