

Homework Chapter 04

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Question

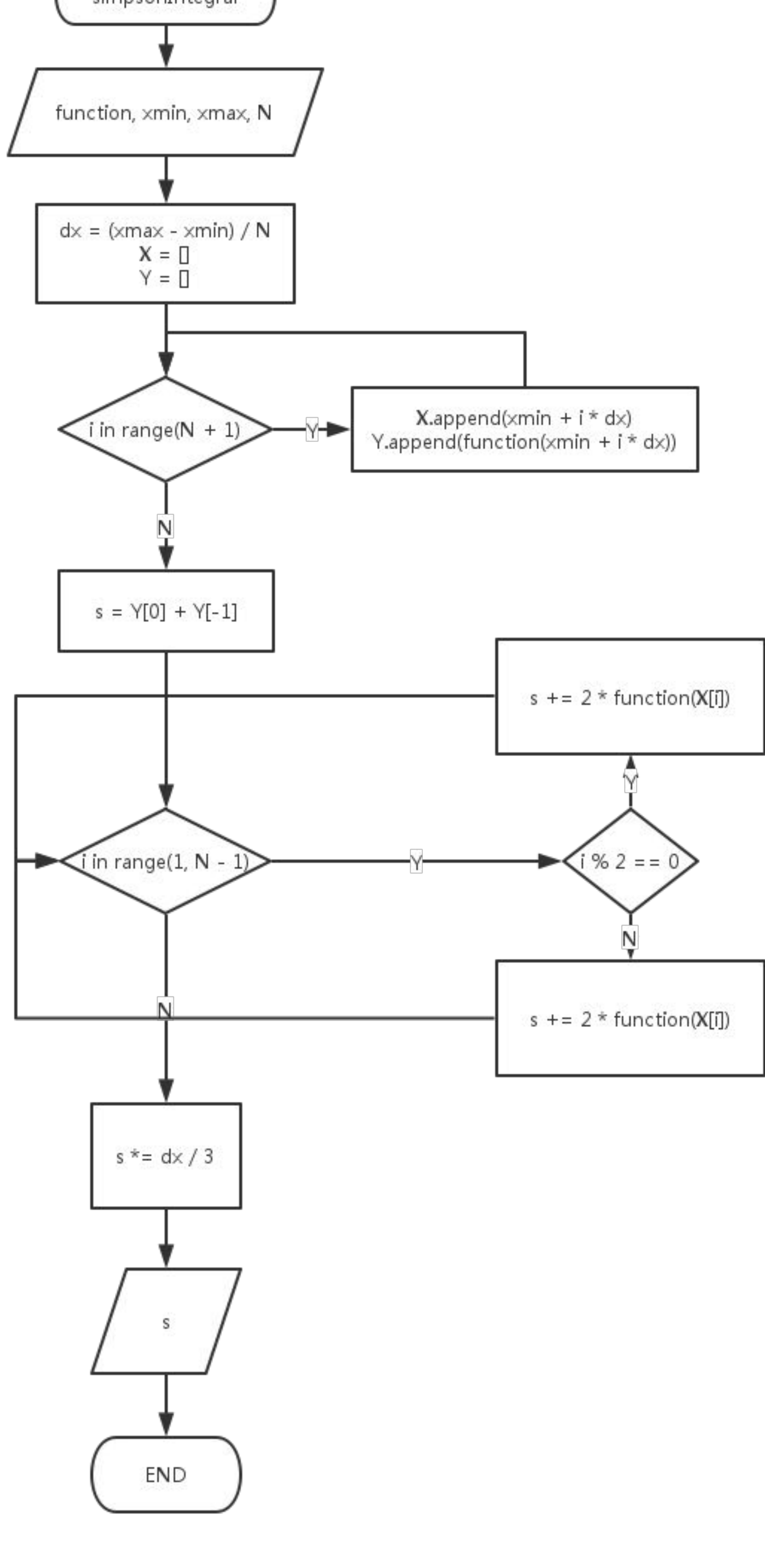
use repeated Simpson quadrature and repeated trapezoid quature Write a program to compute the integral

$$I(f) = \int_1^5 \sin(x)dx, \quad h = 0.1$$

Used function and algorithm.

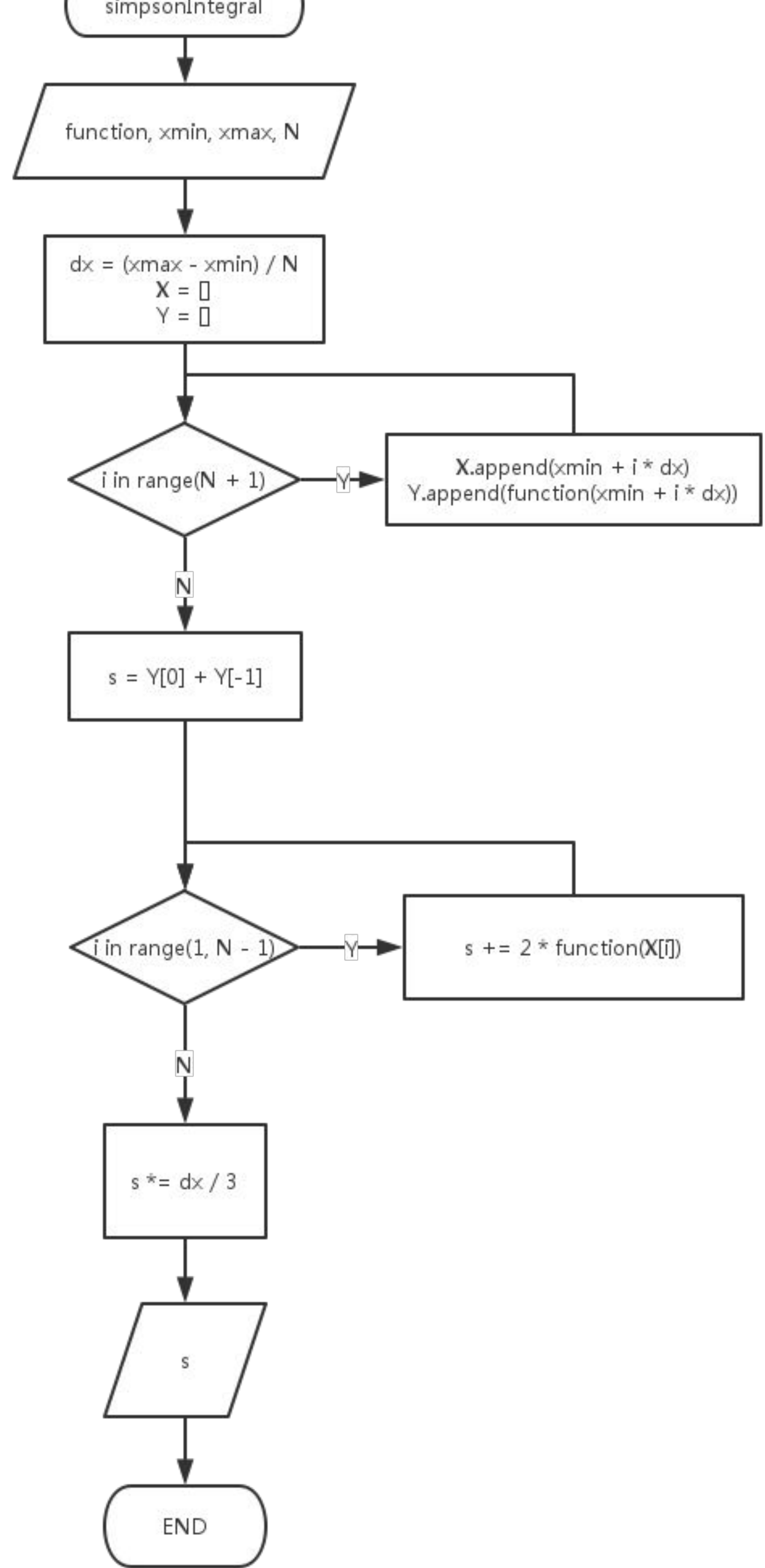
1. Simpson integrals

$$s = \frac{h}{3} (f(0) + 4 \sum_{i=1}^{n-1} f(x_i) + f(n))$$



2. Trapezoid integrals

$$s = \frac{h}{3} (f(0) + 4 \sum_{i=1}^{n-1} f(x_i) + 2 \sum_{i=1, i \neq 2k+1}^{n-1} f(x_i) + f(n))$$



Source Code

```
module integrals
contains
function func(x)
implicit none
real*8::x,func
func = sin(x)
end function func

function simpsonIntegral(xmin,xmax,N)
implicit none
real*8::xmin,xmax,dx,simpsonIntegral
integer::N,i
real*8::X(N+1),Y(N+1)
dx = (xmax-xmin)/N
do i=1,N+1
X(i) = xmin+dx*(i-1)
Y(i) = func(X(i))
enddo
simpsonIntegral = Y(1)+Y(N+1)
do i=2,N-1
if (mod(i,2) .eq. 0) then
simpsonIntegral = simpsonIntegral+4*func(X(i))
else
simpsonIntegral = simpsonIntegral+2*func(X(i))
endif
enddo
simpsonIntegral = simpsonIntegral*dx/3
end function simpsonIntegral

function trapezoidIntegral(xmin,xmax,N)
implicit none
real*8::xmin,xmax,dx,trapezoidIntegral
integer::N,i
real*8::X(N+1),Y(N+1)
dx = (xmax-xmin)/N
do i=1,N+1
X(i) = xmin+dx*(i-1)
Y(i) = func(X(i))
enddo
trapezoidIntegral = Y(1)+Y(N+1)
do i=2,N-1
trapezoidIntegral = trapezoidIntegral + 2*func(X(i))
enddo
trapezoidIntegral = trapezoidIntegral*dx/2
end function trapezoidIntegral

end module integrals

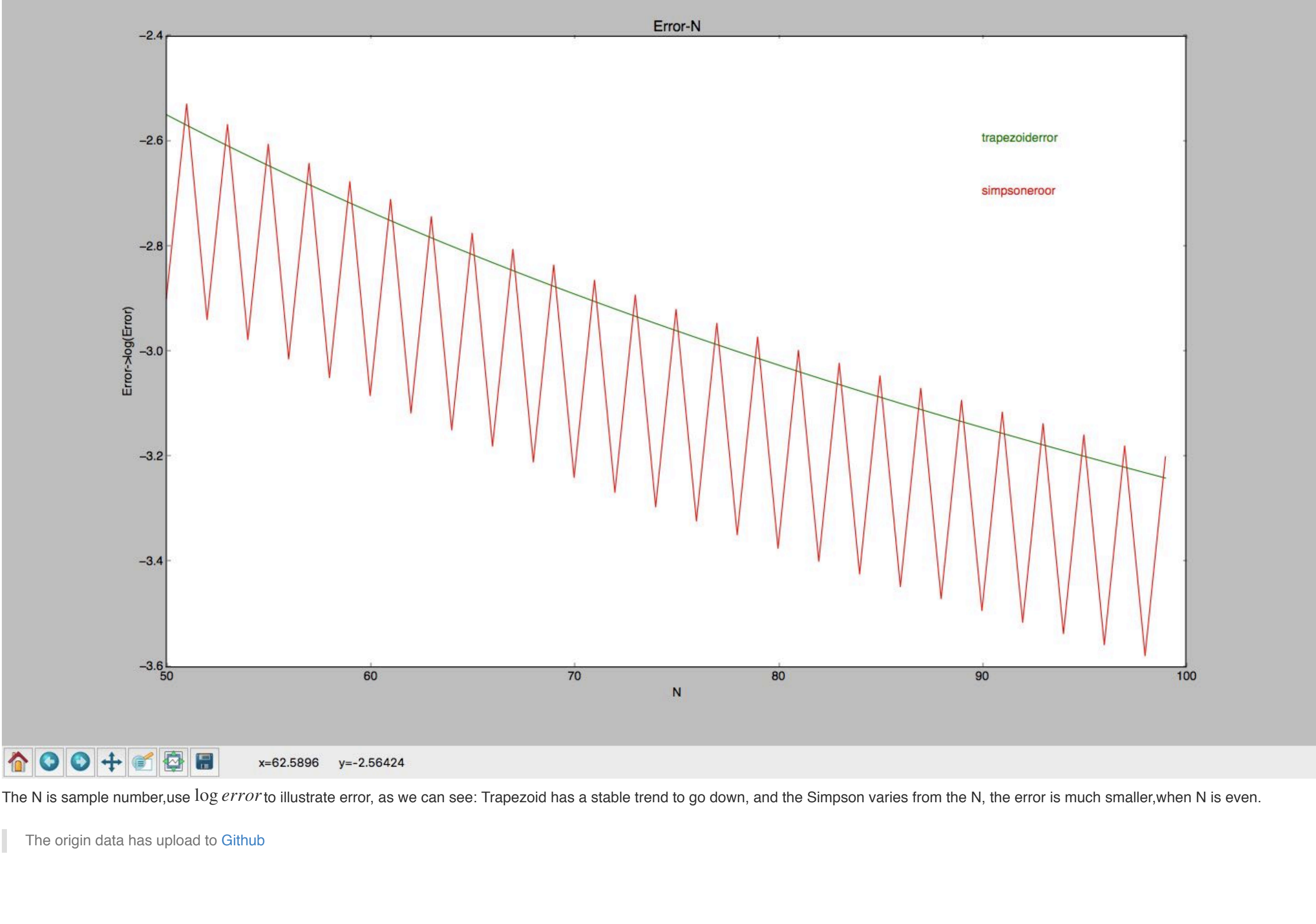
program main
use integrals
implicit none
real*8::xmin,xmax,s
integer::N
xmin = 1
xmax = 5
N = 40
s = simpsonIntegral(xmin,xmax,N)
write(*,*) s
end program main
```

Running Screenshot

```
1. Simpson Interpolation
>> integrals> simpsonIntegral(xmin,xmax,N)
31 function trapezoidIntegral(xmin,xmax,N)
32 implicit none
33 real*8::xmin,xmax,dx,trapezoidIntegral
34 integer::N,i
35 real*8::X(N+1),Y(N+1)
36 dx = (xmax-xmin)/N
37 do i=1,N+1
38 X(i) = xmin+dx*(i-1)
39 Y(i) = func(X(i))
40 enddo
41 trapezoidIntegral = Y(1)+Y(N+1)
42 do i=2,N-1
43 trapezoidIntegral = trapezoidIntegral + 2*func(X(i))
44 enddo
45 trapezoidIntegral = trapezoidIntegral*dx/2
46 end function trapezoidIntegral
47
48 end module integrals
49 program main
50 use integrals
51 implicit none
52 real*8::xmin,xmax,s
53 integer::N
54 xmin = 1
55 xmax = 5
56 N = 40
57 s = simpsonIntegral(xmin,xmax,N)
58 write(*,*) s
59 end program main
0.38763394483591598
[Finished in 0.1s]

2. Trapezoid Interpolation
>> integrals> trapezoidIntegral(xmin,xmax,N)
31 function trapezoidIntegral(xmin,xmax,N)
32 implicit none
33 real*8::xmin,xmax,dx,trapezoidIntegral
34 integer::N,i
35 real*8::X(N+1),Y(N+1)
36 dx = (xmax-xmin)/N
37 do i=1,N+1
38 X(i) = xmin+dx*(i-1)
39 Y(i) = func(X(i))
40 enddo
41 trapezoidIntegral = Y(1)+Y(N+1)
42 do i=2,N-1
43 trapezoidIntegral = trapezoidIntegral + 2*func(X(i))
44 enddo
45 trapezoidIntegral = trapezoidIntegral*dx/2
46 end function trapezoidIntegral
47
48 end module integrals
49 program main
50 use integrals
51 implicit none
52 real*8::xmin,xmax,s
53 integer::N
54 xmin = 1
55 xmax = 5
56 N = 40
57 s = trapezoidIntegral(xmin,xmax,N)
58 write(*,*) s
59 end program main
0.35467147924739217
[Finished in 0.6s]
```

Error analytics



The N is sample number,use log error to illustrate error, as we can see: Trapezoid has a stable trend to go down, and the Simpson varies from the N, the error is much smaller when N is even.

The origin data has upload to [Github](#)