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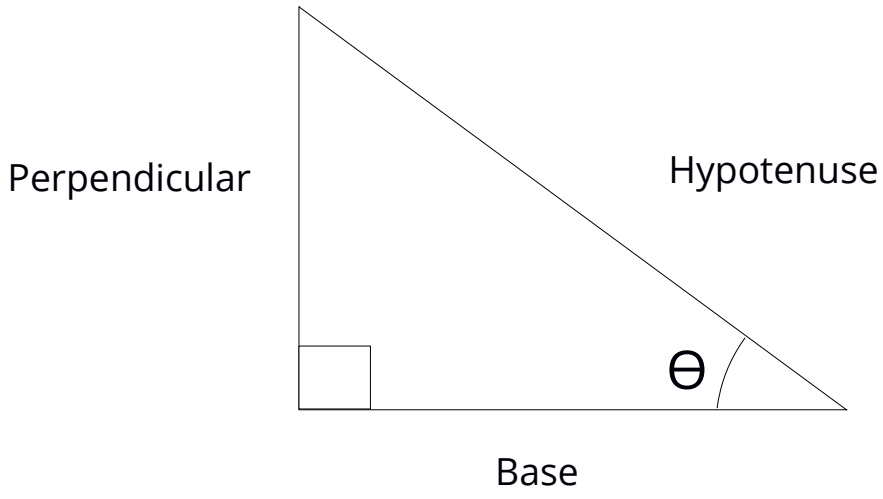
Assignment Number

Problem Statement

Program in C to find the value of sine function for a particular angle given in degree corrected upto 4 decimal places.

Theory

The sine of an acute angle is defined in the context of a right triangle: for the specified angle, it is the ratio of the length of the side that is opposite that angle to the length of the longest side of the triangle (the hypotenuse).



Hence, from the above picture,

$$\sin\theta = \frac{Perperdicular}{Hypotenuse}$$

More generally, sine can be expressed in terms of the length of a certain line segment in a unit circle, or via the expansion of the following infinte series,

$$\sin\theta = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots$$

where x is the degree of the angle in radian. We will use this infinite series expansion to approximate the value of sine for a given angular value.

Example : Let's say we are to find the value of sin(30º).

$$30^{o} = \left(\frac{\Pi}{180} * 30\right) rad = 0.52\, rad$$

$$\sin(0.52) = (0.52) - \frac{(0.52)^3}{3!} + \frac{(0.52)^5}{5!} - \frac{(0.52)^7}{7!} + \ldots$$

$$= (0.52) - (0.0234) + (0.0003) - (2.03 \times 10^{-6}) + \ldots$$

$$= 0.49689 + \ldots$$

$$\simeq 0.5$$

In this way, we can easily approximate the value of sine function for a given angle upto our desired precision.

Algorithm

Input : The value of angle in degree to calculate the sine function for, say deg.

Output : The value for sine function for given degree of angle.

Steps :

Step 1: Print "Enter the value of angle(in degree) : "

Step 2: Input deg

Step 3: Set rad = (Pi/180)*deg // Pi is a constant which stores the value of
// pi upto sufficient precision

Step 4: Set sine = rad, sign = -1, index = 3

Step 5: Repeat through step 5.A to 5.G while(True)

A) Set numer = rad^{index}, denom = 1, j = 1

B) Repeat through step B.i to b.ii while (j <= index)

i. Set denom = denom * j

ii. Set j = j + 1

[End of inner while loop]

C) If(Abs(numer/denom) < 0.0001) // Abs is a function which returns
// the absolute value of a number

Then

i. Break

[End of if structure]

D) Set term = (sign * numer)/denom

E) Set sine = sine + term, index = index + 2, sign = sign * -1

[End of outer while loop]

Step 6: Set orig = Sin(rad) // Sin is a library function which generates the
// value of sine function for a given angle

Step 7: Set error = Abs(sine - orig)

Step 8: Print "The value of sin(" rad ") as per series : " sine

Step 9: Print "The value of sin(" rad ") as per library function : " orig

Step 10: Print "Absolute error : " error

Source Code

```
#include <stdio.h>
#include <math.h>
#define PI acos(-1.0)
int main(){
   float deg;
   printf("Enter the value of angle (in degree) : ");
   scanf("%f", &deg);
   float rad = (PI/180) * deg;       // converting degree to radian
   float sine = rad;                 // intiailzing first term
   int sign = -1, index = 3;
   while(1){
      float numer = pow(rad, index);          // x^index
      float j = 1, denom = 1;
      while(j <= index)
         denom *= j++;                        // index!
      if(fabs(numer/denom) < 0.0001)   // precision controller
         break;
      float term = (sign * numer)/denom;
      sine = sine + term, index = index + 2, sign *= -1;
   }
   float orig = sin(rad);            // value from library function
   float error = fabs(orig-sine);          // absolute error
   printf("The value of sin(%g) as per series : %g", rad, sine);
   printf("\nThe value of sin(%g) as per library function : %g", rad, orig);
   printf("\nAbsolute error : %g\n", error);
   return 0;  }
```

Input and Output

Set 1 :

Enter the value of angle (in degree) : -30

The value of sin(-0.523599) as per series : -0.500002

The value of sin(-0.523599) as per library function : -0.5

Absolute error : 2.14577e-06

Set 2 :

Enter the value of angle (in degree) : 67

The value of sin(1.16937) as per series : 0.920494

The value of sin(1.16937) as per library function : 0.920505

Absolute error : 1.11461e-05

Set 3 :

Enter the value of angle (in degree) : 90

The value of sin(1.5708) as per series : 1

The value of sin(1.5708) as per library function : 1

Absolute error : 3.45707e-06

Discussion

1. The computational complexity of this method is very high.
2. The program will depend on the size of datatypes on the machine it runs. Hence it won't give correct and equal result on every machine.
3. On the extension of above point, this program won't be able to calculate the sine function for higher values because of type overflows.