Aim : To find the area of the circle with given radius with using Monti Carlo Method

Theory :

Monti Carlo Method:

They are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. The underlying concept is to use randomness to solve problems that might be deterministic in principle.

Finding the are of the Circle:

For finding the area we consider a square area that have area greater than the circle and put the circle at the centre of the square . Then generate random numbers and count how many are outside and inside the circle. And we know that the probability of finding the random point inside the circle is equal to its ratio of the area of circle and square then conversally we can say that ratio of area of circle and square is equal to the ratio of points inside to the total points we use. Then area of the circle is equal to the ratio of the points multiply with area of square.

Probability of find the random point inside the circle = area of circle / area of squae

and Probability of find the random point inside the circle = inner points / total points

then area of circle / area of square = inner points / total points

then area of circle = (inner points/total points)*area of square

Program in Fortran 95:

```
program monticarlo

  implicit none
  real x ,y ,m ,n ,radius ,area ,length ,distance ,error ,area2
  real, parameter :: pi = 3.141592653589793
  integer all , inner ,i
  logical f1,f2

! getting the input

  print *, "Enter the value of the radius of the circle :: "
  read(*,*)radius
  print *, "Enter the number of the points uses :: "
  read(*,*)all
```

```
! check the value of the radius and points fit for program

   if (radius <= 0)then
      print *, "The Program is not working with these value of the radius"
      call Exit(1)
   endif

   if (all <= 0)then
      print *, "The Program is not working with these value of the points maps"
      call Exit(1)
   endif

! check exiting file and open it and if file doesn't exit then create the files

   inquire(file="allpoints.dat",exist=f1) ! for checking the existance of the file
   inquire(file="innerpoints.dat",exist=f2)
   if (f1) then
      open(1,file="allpoints.dat",status="replace")
   else
      open(1,file="allpoints.dat",status="new",action="write")
   endif
   if (f2) then
      open(2,file="innerpoints.dat",status="replace")
   else
      open(2,file="innerpoints.dat",status="new",action="write")
   endif

! defining the square space use for program
   length = 2*radius

   inner = 0

! loop for generating the random points and check how many are inside the circle
   do i = 1,all
      call random_number(m)
      x = length*m ! this because random_number generate only value between 0 and 1
      call random_number(n)
      y = length*n
      write(1,*) x,y
      distance = (x-radius)**2 + (y-radius)**2
      if (distance <= radius**2) then
         write(2,*) x,y
         inner = inner + 1
      endif
```

```
    enddo

  !  printing the all result and calculating the error

    area = ((real(inner))/real(all))*(length**2)

    print *, "The area of the circle by Monti Carlo method is :: ",area
    print *, "Inner points :: ",inner
    area2 = pi*(radius**2)
    error = (area - area2)*100/area
    print *, "The area by simple formula is :: ", area2
    print *, "The percentage error :: ", error

    close(1) ! Closing the files
    close(2)

    stop
    end program
```

Ouput of Program :

```
 Enter the value of the radius of the circle ::
5
 Enter the number of the points uses ::
1000
 The area of the circle by Monti Carlo method is ::    77.4000015
 Inner points ::          774
 The area by simple formula is ::    78.5398178
 The percentage error ::   -1.47263086
```

Results: