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IMPLEMENTATION OF LenQuad (LINEAR QUADRATIC) MATHEMATICAL MODEL IN PYTHON TO ESTIMATE THE VALUE OF PI USING ONE QUADRANT OF A GIVEN CIRCLE. FURTHER CHECKING THE EFFICIENCY OF LenQuad METHODOLOGY USING ASYMPTOTIC NOTATIONS

6405 – Cadet E Madeshwaran
Class- XII 2023-24,
Sainik School Amaravathinagar
Post: Amaravathinagar, Udumalpet Taluka, Tirupur District, Tamilnadu State

Pi (π) is one of the most important and fascinating numbers in mathematics. Roughly 3.14, it is a constant that is used to calculate the circumference of a circle from that circle's radius or diameter.[1] It is also an irrational number, which means that it can be calculated to an infinite number of decimal places without ever slipping into a repeating pattern.[2] This makes it difficult, but not impossible, to calculate precisely.

This manuscript specifically addresses finding of Pi value using different approach called LinQuad Mathematical Model. In computer science efficiency of a program solely depends on time factor of processing statement or statement block. Further the amount of memory it is being used for processing also matters in calculating the space complexity of the program, hence the time complexity and space complexity of Linear Quad Mathematical model code is examined. The purpose is to provide an alternative methodology for finding the value of pi.

KEYWORDS: *Circumference(C), Radius(r), Linear Quard (lq), Runtime Complexity (rc), BigO(n), Big ThetaΘ(n), Big OmegaΩ(n).*

1. INTRODUCTION

Pi The number π is a mathematical constant that is the ratio of a circle's circumference to its diameter, approximately equal to 3.14. The number π appears in many formulae across mathematics and physics. It is an irrational number, meaning that it cannot be expressed exactly as a ratio of two integers, although fractions such as 22/7 are commonly used to approximate it. Consequently, its decimal representation never ends, nor enters a permanently repeating pattern. It is a transcendental number, meaning that it cannot be a solution of an equation involving only sums, products, powers, and integers. [4]

2. PROBLEM DEFINITION

Estimating the pi value using existing methods have pros and cons depending upon the application and the methodology being used in estimating the pi value.

Most commonly used algorithms to find pi value are graphical approach and monte carlo approach. This paper finds a new algorithm to estimate the value of pi. The function called LenQuad() finds the value of pi using continuous and linear plotting of points on a quadrant.

3. METHODOLOGY

This program depends profoundly on the concepts of coordinate geometry

The first step is to take a Cartesian plane [x-y plane] and choose the first quadrant. The usage of first quadrant is because of its property of having positive value in both the axes hence reducing the complexity of the code.

If we draw a circle with origin as centre, exactly a fourth of its circumference will lie in the first quadrant.

The first formula to use is the equation of circle, also commonly known as the circle formula:

$$(x-h)^2+(y-k)^2=r^2$$

The h and k in this formula denote the centre of the circle. Since we use origin as the centre, this formula becomes:

$$x^2+y^2=r^2$$

For our convenience we take the radius of the circle as 5. So the range of the coordinates will be (5,0) $\longrightarrow$ (0,5)

Here, a new concept I discovered comes into play.

We know that $x^2+y^2=r^2$ and r is 5. Therefore, r^2 is fixed as 25. If we look into our range, x starts from 5 and finishes at 0 and the vice versa for y.

$$5^2+02=25$$
$$25+0=25$$

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So, to find the adjacent point, we decrease the square of x and increase the square of y simultaneously. Slowly, the value of x reaches 0 and y reaches 5.

$24+1=25$; $x=\sqrt{24}, y=\sqrt{1}$
$23+2=25$; $x=\sqrt{23}, y=\sqrt{2}$
$22+3=25$; $x=\sqrt{22}, y=\sqrt{3}$
…
…
…
$0+25=25$; $x=\sqrt{0}, y=\sqrt{25}$

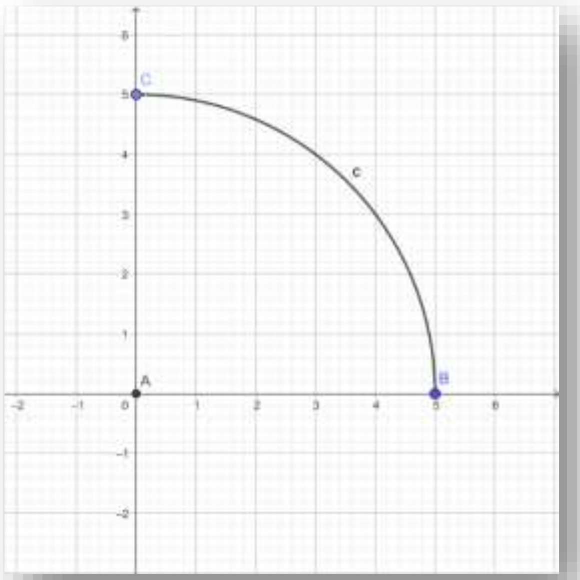
If we plot these, we get the arc of the circle in the first quadrant. Once we acquire all the points in this arc, we calculate the distance between them and add them together.

To do this we apply the distance formula:

$$d=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

A(0,0); B(5,0); C(0,5)

c = length of arc



This process will give us the length of the arc of the quadrant. We know that 4 times the length of a quadrant is equal to the circumference of a full circle.

$$C = \pi * diameter$$
$$\pi = C/diameter$$

4.LENQUAD MATHEMATICAL MODEL

Implementation:

The following code implements the LenQuad() function.

```
LenQuad()
   from math import sqrt
   x=25
   y=0
   prevtup=(5,0)
   c=0
   while x>=0:
        x-=0.0001
        if x<0:
             pass
        else:
          mx=sqrt(x)
     y+=0.0001
     my=sqrt(y)
     curtup=(mx,my)
     d=((curtup[0]-
prevtup[0]))**2+((curtup[1]-
prevtup[1]))**2
        d=sqrt(d)
        c+=d
        prevtup=curtup
   cir=c*4
   pie=cir/10.00
   print(pie)
LenQuad()
```

5. COMPLEXITY OF ALGORITHM

In computer science, analysis of algorithms is a very crucial part. It is important to find the most efficient algorithm for solving a problem. It is possible to have many algorithms to solve a problem, but the challenge here is to choose the most efficient one. [5] There are multiple ways to design an algorithm, or considering which one to implement in an application. When thinking through this, it's crucial to consider the algorithm's time complexity and space complexity. [6]

6. SPACE COMPLEXITY

The space complexity of an algorithm is the amount of space (or memory) taken by the algorithm to run as a function of its input length, n. Space complexity includes both auxiliary space and space used by the input. [6] Auxiliary space is the temporary or extra space used by the algorithm while it is being executed. Space complexity of an algorithm is commonly expressed using Big (O(n)) notation. [6] The Space complexity is ignored in this research paper, since the space complexity of particular problem is not considered so important.

7. TIME COMPLEXITY

The time complexity of an algorithm is the amount of time taken by the algorithm to complete its process as a function of its input length, n. The time complexity of an algorithm is commonly expressed using asymptotic notations:[6]

Big O - O(n)
Big Theta - Θ(n)
Big Omega - Ω(n)

It's valuable for a programmer to learn how to compare performances of different algorithms and choose the best time-space complexity to solve a particular problem in the most efficient way possible.[6]

Big O notation is used in Computer Science to portrait the performance or complexity of an algorithm. Big O specifically defines the worst-case scenario of an algorithm, and can be used to describe the execution time required or the space used (e.g. in memory or on disk) by an algorithm. Here O stands for order of growth. Big Theta(Θ) is used to represent the average case scenario of an algorithm and can be used to describe the execution time required or the space used (e.g. in memory or on disk) by an algorithm. Big Omega (Ω)is used to represent the best case scenario of an algorithm and can be used to describe the execution time required or the space used (e.g. in memory or on disk) by an algorithm. These three methods are the most common and very popular methods of design and analysis of an algorithm which are used for finding the efficiency of the program.

These asymptotic notations are representing the execution time of given algorithm. These are acting like handy tools to identify the efficiency of an algorithm.

8. RUNTIME COMPLEXITY OF CHECKING LENQUAD() FUNCTION

For an input value 5 the runtime complexity of LenQuad() function at different time intervals/run.

LenQuad() function's Time Complexity
0.36827564239501953
0.3634049892425537
0.37503552436828613
0.39061808586120605
0.37500762939453125
0.4374504089355469
0.35936832427978516

The runtime complexity of the LenQuad() function is as under:

Worst case- BigO(n)

9. CONCLUSION

There are numerous algorithms in computer science to calculate value of pi, these algorithms' efficiency is solely based on the range of value and hardware specifications. The LenQuad methodology requires minimal hardware specification and works for smaller numbers with a greater efficiency.

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